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PATOUN's

TREATISE

OF

NAVIGATION.

A COMPLETE

TREATISE

OF PRACTICAL

NAVIGATION,

Demonſtrated from it's Firſt

PRINCIPLES:

With all the Neceſſary

TABLES.

To which are added

The uſeful THEOREMS of Mensuration,
Surveying, and Gauging;

With their Application to Practice.

By ARCHIBALD PATOUN, F.R.S.

THE EIGHTH EDITION,
Reviſed and corrected by the Author, with large Additions and Alterations.

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Traver
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To which are added all the Tables neceſſary in Navigation *pending on* Spherical Trigonometry, *which would require a particular Volume to explain it. There are indeed two or three Problems neceſſary in Practice, which depend on the Reſolution of Spherical Triangles; but for the Solution of theſe, I have laid down ſuch clear and ſhort Rules, that nobody can miſtake the Manner of applying them.*

I know ſome are of Opinion, that the Demonſtrations are not to be eaſily learnt by every Capacity, on which Account they teach the Practice only. This Book is therefore ſo written as to ſerve for their Purpoſe likewiſe, becauſe they may take the Rules alone without their Reaſons. It is true indeed, that there may be great Difficulty in finding out a proper Demonſtration; but after it is found, it is eaſier to be underſtood than that of which it is the Reaſon: And therefore they who are not capable of underſtanding the Demonſtrations, are much leſs capable of underſtanding the practical Rules which depend on them. And I am inclined to believe, that what is commonly attributed to want of Genius in the Scholar, is often owing to Want of Method and Perſpicuity in the Maſter.

In preparing this Treatiſe for the Preſs, I own myſelf obliged to Mr. STIRLING, F. R. S. *who on his firſt ſeeing my Papers, ſo far approved both the Matter they contained, and of the Order in which they were put together, as to think them fit to be made publick with very little Alteration.*

PATOUN's

TREATISE

OF

NAVIGATION.

make it publick. The favourable Reception it has met with ſince it was firſt publiſhed, makes me flatter myſelf that it is of ſome Uſe, and as ſuch Your known Candour and Humanity, and Zeal for any thing uſeful to Society, emboldens me to lay it under Your Protection. But when I conſider the high Character You ſo juſtly poſſeſs, both as a conſummate General and ſincere Promoter of uſeful Knowledge, I am fully ſenſible of the Unworthineſs of this Offering; however, if You are pleaſed to accept of it, I ſhall have this Benefit by it, of declaring publickly that I am with the greateſt Reſpect,

S I R,

Your moſt Obliged,

and moſt Obedient,

Humble Servant,

Archibald Patoun.

THE PREFACE.

THERE are ſo many Books of Navigation already extant, that it may ſeem impertinent to trouble the World with a new One: Eſpecially ſince ſome good Mathematicians, both at Home and Abroad, and many who are perfect Maſters of the Practice, have written on this Subject. The former of theſe being fond of ingenious Speculations, have generally been too prolix on the Theory, and too ſhort on the practical Part. Whereas the latter have in a great Meaſure neglected the Theory, and not being very ſolicitous about Language or Method, have delivered the practical Rules in ſuch a Manner, as they cannot be eaſily comprehended, and much leſs remembered, eſpecially ſince there is ſeldom Mention made of the Reaſons on which they depend.

But I am very far from finding fault with all the Books on this Subject; for there are ſome very full both on Theory and Practice, againſt which I have no other Objection, but that they are too tedious to be taught, and too dear to be purchaſed by moſt People.

Youth ought to learn the Elements from ſhorter Treatiſes, and afterwards at their Leiſure ſhould read general Syſtems, in order to perfect them.

For theſe Reaſons, I have ventured to publiſh this ſmall Treatiſe; wherein I have made it my chief Buſineſs to keep a due Medium betwixt the two Extremes, into which the ſpeculative Writers on the one Hand, and the practical Ones on the other, are apt to run. I have laid down all the uſeful Rules, and troubled the Reader with no more of the Theory than is neceſſary to explain them. I have alſo explained the Principles of Menſuration, Surveying, and Gauging, and ſhewed how they are applied to Practice, in order that my Book might better anſwer the particular End for which it is deſigned, namely, the Inſtruction of the young Gentlemen educated at the Publick Schools.

As for the particular Contents of each Section, the Reader will find them after this Preface, and therefore they need not be repeated here. I ſhall only obſerve, that I have deſignedly omitted Great Circle Sailing, *as being only ſpeculative, and depending*

THE PRINCIPLES OF NAVIGATION.

DEFINITION.

NAVIGATION is that Art whereby we are enabled to conduct, or carry a Ship, from one Port to another.

This Science depends upon ſome Parts of the Mathematics, which muſt be known before we can treat of it.; therefore we ſhall firſt lay down the Principles of *Geometry*.

SECT. I.

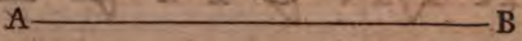
Of ſuch Geometrical Propoſitions as are abſolutely neceſſary for NAVIGATION.

ART. 1. GEOMETRY is that Science wherein we conſider the Properties of *Magnitude.*

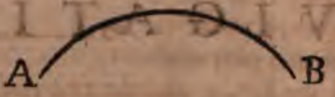
2. A Point is that which is not made up of Parts, or which is of itſelf indiviſible, as A ●

3. A Line is a Length without Breadth, as B ———

4. The Extremities of a Line are Points; as the Extremities of the Line A B, are the Points A and B.



5. The neareſt Diſtance between the Extreams A and B, is a ſtrait Line, as A B in the former Figure; any other Diſtance is a curve Line, as A B.



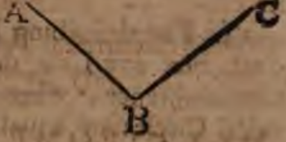
6. A Surface is that which is conſidered as having only Length and Breadth, but no Thickneſs, as B.

7. The Terms of a Surface are Lines.

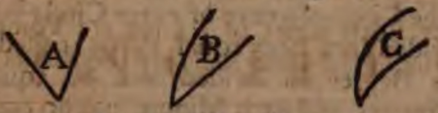
8. A plane Surface is that which lies equally between it's Extreams.

9. The Inclination between two Lines meeting one another (provided they do not make one con-

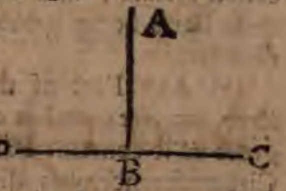
tinued ſtrait Line) or the Opening between them, is called an Angle; thus the Inclination of the Lines A B and C B, meeting one another at B, or the Opening between the two Lines A B and C B, is called an Angle.



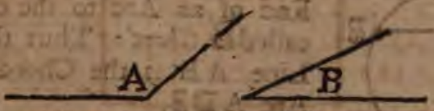
10. When the Lines forming the Angle are right Lines, then it is called a right-lined Angle, as A; if one of them be right and the other curved, it is called a mixed Angle, as B; if both of them be curved, it is called a curve-lined Angle, as C.



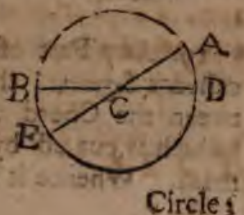
11. If a right Line, A B, fall upon another, D C, ſo as to incline neither to the one Side nor to the other, but make the Angles A B D, A B C, on each Side equal to one another, then the Line A B is ſaid to be perpendicular to the Line D C; and the two Angles are called Right Angles.



12. An obtuſe Angle is that which is greater than a right one, as A; and an acute Angle, that which is leſs than a right one, as B.



13. If a right Line D C, be faſtened at one of it's Ends C, and the other End D be carried quite round, then the Space comprehended is called a *Circle*; the curve Line deſcribed by the Point D, is called the *Periphery*, or *Circumference* of the



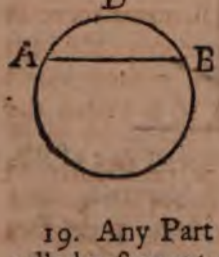
Circle; the fixed Point C is called the *Center* of it.

14. The deſcribing Line, C D, is called the Radius, *viz.* any Line drawn from the Center to the Circumference; whence all Radii of the ſame or equal Circles are equal.

15. Any Line drawn through the Center, and terminated both Ways by the Circumference, is called a *Diameter*, as BD is a Diameter of the Circle BADE. And the Diameter divides the Circle and Circumference into two equal Parts, and is double the Radius.

16. The Circumference of every Circle is ſuppoſed to be divided into 360 equal Parts, called *Degrees*, and each Degree is divided into 60 equal Parts, called *Minutes*; and each Minute into 60 equal Parts, called *Seconds*; and theſe into *Thirds*, *Fourths*, &c. theſe Parts being greater or leſs according as the Radius is.

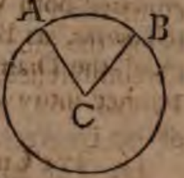
17. Any Part of the Circumference is called an *Arch*, or *Arc*; and is called an Arc of as many Degrees as it contains Parts of the 360, into which the Circumference was divided: Thus if A D (in the former Figure) be the $\frac{1}{8}$ of the Circumference, then the Arc A D is an Arc of 45 Degrees.



18. A Line drawn from one End of an Arc to the other, is called a *Chord:* Thus the right Line A B is the Chord of the Arc A D B.

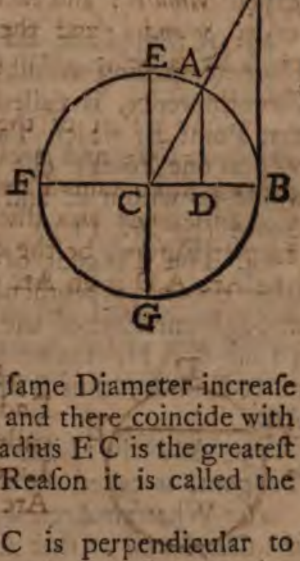
19. Any Part of a Circle cut off by a Chord, is called a *Segment*; thus the Space comprehended between the Chord A B and Circumference A D B (which is cut off by the Chord A B) is called a Segment. Whence it is evident,

- *1ſt*, That all Chords divide the Circle into two Segments.
- *2dly*, The leſs the Chord is, the more unequal are the Segments, and *è contra.*
- *3dly*, When the Chord is greateſt, *viz.* when it is a Diameter, then the Segments are equal, *viz.* each a Cemicircle.



20. Any Part of a Circle (leſs than a Semicircle) contained between two Radii and an Arc, is called a *Sector*; thus the Space contained between the Radii A C, B C, and Arch A B, is called a Sector.

21. The right Sine of an Arc is a Perpendicular, drawn from one End of the Arc, to a Diameter paſſing through the other End of the ſame Arc: Thus A D is the right Sine of the Arc A B, it being a Perpendicular to F B, a Diameter paſſing through B, the other End of the Arc A B.



The Sines ſtanding on the ſame Diameter increaſe till they come to the Center, and there coincide with the Radius: Therefore the Radius E C is the greateſt poſſible Sine, and for that Reaſon it is called the *Whole-Sine.*

Since the Whole-Sine E C is perpendicular to the Diameter F B (by *Def*, 21.) therefore producing E C to G, the two Diameters F B, E G, will croſs one another at right Angles, and divide the Circumference into four Parts, E B, B G, G F, and F E;

FE; and theſe four Parts are equal to one another (by *Def.* 11.) and ſo EB a Quadrant, or fourth Part of the Circumference: Therefore the Radius EC is always the Sine of the Quadrant, or fourth Part of the Circle EB.

Sines are ſaid to be of ſo many Degrees, as the Arch contains Parts of the 360, into which the Circumference is ſuppoſed to be divided; ſo the Radius being the Sine of a Quadrant, or fourth Part of the Circumference, which contains 90 Degrees (the fourth Part of 360) therefore the Radius muſt be the Sine of 90 Degrees.

22. The Line DB intercepted between the Extremity D of the right Sine and the lower End B of the Arch, is called the verſed Sine of the Arch AB.

23. A right Line BH, drawn perpendicular to a Diameter paſſing through any Point B, taken in the Circumference, is called a *Tangent* to the Circle in that Point B, which Tangent can touch the Circle only in one Point; elſe if it touched it in more, it would go within it, and ſo not be a Tangent, but a Chord (by *Art.* 18.)

24. The Tangent of any Arch AB, is a right Line drawn perpendicular to a Diameter, paſſing through one End of the Arch B, and terminated by a Line CAH, drawn from the Center through the other End A; thus BH is the Tangent of the Arch AB.

25. And the Line CH, which terminates the Tangent, is called the Secant of the Arch AB.

26. What an Arch wants of a Quadrant is called the *Complement* of that Arch: Thus AE being what the Arch AB wants of the Quadrant EB, is called the Complement of the Arch AB.

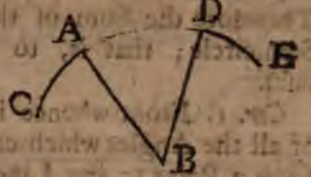
27. And what an Arch wants of a Semicircle is called the *Supplement* of that Arch; thus ſince AF

is what the Arch A B wants of the Semicircle B A F, it is the Supplement of the Arch A B.

28. The Sine, Tangent, *&c.* of the Complement of any Arch, is called the Co-Sine, Co-Tangent, *&c.* of that Arch: Thus the Sine, Tangent, *&c.* of the Arch A E, is called the Co-Sine, Co-Tangent, *&c.* of the Arch A B.

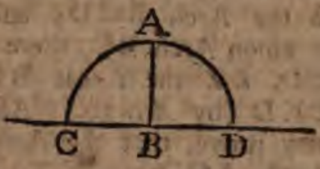
29. The Sine of the Supplement of an Arch is the ſame with the Sine of the Arch itſelf; for drawing them according to the Definitions, there reſults the very ſame Line.

30. A right-lined Angle is meaſured by an Arch of a Circle deſcribed upon the angular Point as a Center, and comprehended between the two Legs that form the Angle; thus the Angle A B D is meaſured by the Arch AD of the Circle CADE, deſcribed upon the Point B as a Center; and the Angle is ſaid to be of as many Degrees as the Arch contains: So if the Arch A D contains 45 Degrees, then the Angle A B D is ſaid to be an Angle of 45 Degrees.



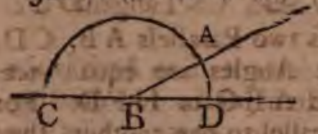
Hence Angles are greater or leſs, according as the Arch deſcribed about the angular Point, and terminated by the two Legs, contains a greater or leſs Number of Degrees.

31. When one Line A B falls perpendicularly on another, as C D, then the Angles on each Side are right ones (by the 11th) and deſcribing a Circle on the Center B, ſince the Angles ABC, ABD, are equal, their Meaſures muſt be ſo too, *i. e.* the Arches AC, AD, muſt be equal; but the whole C A D is



a Semicircle, ſince C D, a Line paſſing through the Center B, is a Diameter; therefore each of the Parts A C, A D, is a Quadrant, *i. e.* 90 Degrees; ſo the Meaſure of a right Angle is always 90 Degrees.

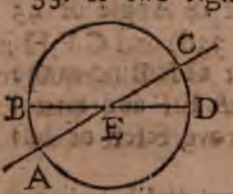
32. If one Line A B fall obliquely upon another, C D, the Sum of the two Angles ABC, ABD, is always equal to the Sum of two right Angles. For on the Point B deſcribe the Circle C A D, it is then plain, that C A D is a Semicircle (by the 15;) but C A D is equal to C A and A D, the Meaſures of the two Angles: Therefore the Sum of the two Angles is equal to a Semicircle; that is, to two right Angles (by the laſt).



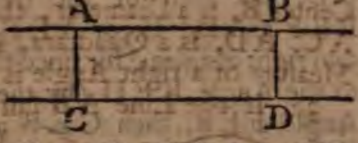
Cor. 1. From whence it is evident, that the Sum of all the Angles which can be made by Lines drawn from a Point in any Line, on the ſame Side thereof, are equal to two right Angles.

2. And that all the Angles which can be made about a Point, are equal to four right ones.

33. If two right Lines, A C, B D, croſs each other as in E, the oppoſite Angles BEA, CED, BEC, and AED, are reſpectively equal. For upon the Point E, as a Center, deſcribe the Circle A B C D, then becauſe ABC is a Semicircle, as alſo BCD (by the 15th) therefore the Arch A B C is equal to the Arch B C D; and from both taking the common Arch B C, there will remain A B equal to C D, *i. e.* the Angle B E A equal to the Angle C E D (by *Art.* 30.) After the ſame Manner we may prove, that the Angle B E C is equal to the Angle A E D.

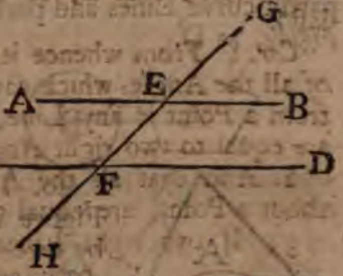


34. Lines which are equally diſtant from one another are called *Parallel Lines*; as A B, C D.



35. If a Line G H croſs two Parallels A B, C D, the external and oppoſite Angles are equal, *viz.* G E B equal to C F H, and A E G to H F D. For ſince A B and C D are parallel to one another, they may be conſidered as one broad Line, and G H croſſing it; then the vertical or oppoſite Angles G E B, C F H are equal (by the 33d,) as alſo A E G and H F D by the ſame.

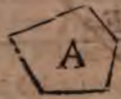
36. If a Line G H croſs two Parallels A B, C D, then the alternate Angles, *viz.* A E F and E F D, or C F E and F E B are equal; that is, the Angle A E F is equal to the Angle E F D, and the Angle C F E is equal to the Angle F E B, for G E B is equal to A E F (by the 33d) and C F H is equal to E F D by the ſame, but G E B is equal to C F H by the laſt. Therefore A E F is equal to E F D; the ſame Way we may prove F E B equal to E F C.

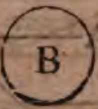


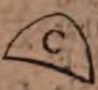
37. If a Line G H croſs two parallel Lines A B, C D, then the external Angle G E B is equal to the internal oppoſite one E F D, or G E A equal to C F E. For the Angle A E F is equal to the Angle E F D by the laſt; but A E F is equal G E B (by the 33d) therefore G E B is equal to E F D; the ſame Way we may prove A E[illegible] equal to C F E.

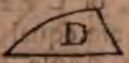
38. If a Line G H croſs two parallel Lines A B, C D, the Sum of the two internal Angles, *viz.* B E F and D F E, or A E F and C F E are equal to two right Angles; for ſince the Angle G E B is equal to the Angle E F D (by the laſt,) to both add the Angle F E B, then G E B and B E F are equal to B E F and D F E; but G E B and B E F are equal to two right Angles (by the 32d,) therefore B E F and D F E are alſo equal to two right Angles. The ſame Way we may prove that A E F and C F E are equal to two right Angles.

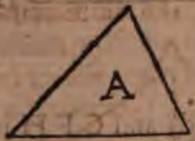
39. A Figure is any Part of Space bounded by Lines or a Line. If the bounding Lines be ſtrait, it is called a *Rectilineal Figure*, as A; if they be curved, it is called a *Curvilineal Figure*, as B or C; if they be partly curve Lines and partly ſtrait, it is called a *mixt Figure*, as D.











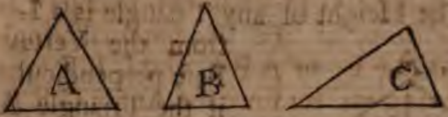
40. The moſt ſimple rectilineal Figure is that which is bounded by three right Lines, and is called a *Triangle*, as A.

41. Triangles are divided into different Kinds, both with reſpect to their Sides and Angles: with reſpect to their Sides, they are commonly divided into three Kinds, *viz.*

42. A Triangle having it's three Sides equal to one another, is called an *Equilateral Triangle*, as A.

43. A Triangle having two of it's Sides equal to one another, and the third Side not equal to either of them, is called an *Iſoſceles Triangle*, as B.

44. A Triangle having none of it's Sides equal to one another, is called a *Scalene Triangle*, as C.

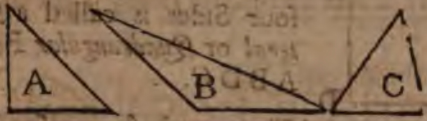


45. Triangles, when denominated by their Angles, are divided into three different Kinds, *viz.*

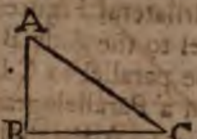
46. A Triangle having one of it's Angles right, is called a *Right-Angled Triangle*, as A.

47. A Triangle having one of it's Angles obtuſe, or greater than a right Angle, is called an *Obtuſe-Angled Triangle*, as B.

48. Laſtly, a Triangle having all it's Angles acute, is called an *Acute-Angled Triangle*, as C.

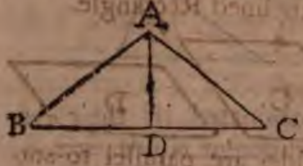


49. In all right-angled Triangles, the Sides comprehending the right Angle are called the Legs, and the Side oppoſite to the right Angle is called the *Hypothenuſe*. Thus in the right-angled Triangle A B C (the right Angle being at B) the two Sides A B and B C which comprehend the right Angle A B C, are the Legs of the Triangle, and the Side A C, which is oppoſite to the right Angle A B C, is the Hypothenuſe of the right-angled Triangle A B C.



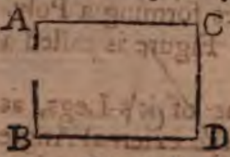
50. Both obtuſe and acute-angled Triangles are in general called *Oblique-Angled Triangles*, in all which any Side is called the *Baſe*, and the other two the Sides.

51. The Height of any Triangle is a Line drawn from the Vertex to the Baſe perpendicularly; thus if the Triangle A B C be propoſed, and BC it's Baſe, then A will be the Vertex, *viz.* The Angle oppoſite to the Baſe; and if from A you draw the Line A D perpendicular to B C, then the Line A D is the Height of the Triangle A B C ſtanding on B C as it's Baſe.



Hence all Triangles ſtanding between the ſame Parallels have the ſame Height, ſince all the Perpendiculars are equal by the Nature of Parallels.

52. A Figure bounded by four Sides is called a *Quadrilateral* or *Quadrangular* Figure, as A B D C.



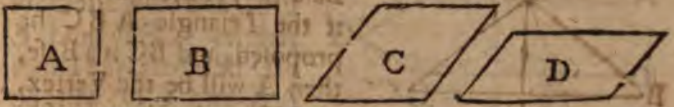
53. Quadrilateral Figures whoſe oppoſite Sides are parallel, are called *Parallelograms.* Thus in the quadrilateral Figure A B D C, if the Side A C be parallel to the Side B D which is oppoſite to it, and A B be parallel to C D, then the Figure A B D C is called a Parallelogram.

54. A Parallelogram having all it's Sides equal and Angles right, is called a *Square*; as A.

55. That which hath only the oppoſite Sides equal and it's Angles right, is called a *Rectangle*; as B.

56. That which hath equal Sides but oblique Angles, is called a *Rhombus*, as C; and is ſometimes called an inclined Square.

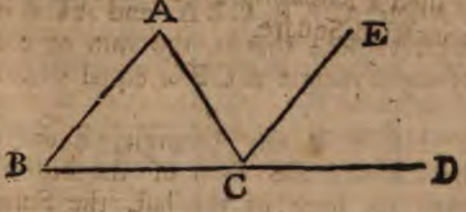
57. That which hath only the oppoſite Sides equal and the Angles oblique, is called a *Rhomboides*, as D; and may be conceived as an inclined Rectangle.



58. When none of the Sides are parallel to another, then the quadrilateral Figure is called a *Trapezium.*

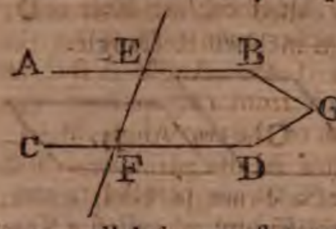
59. Every other right-lined Figure, that has more Sides than four, is in general called a *Polygon.* And Figures are called by particular Names according to the Number of their Sides, *viz.* One of five Sides is called a *Pentagon*, of ſix a *Hexagon*, of ſeven a *Heptagon*, and ſo on. When the Sides forming a Polygon are equal to one another, the Figure is called a regular Figure or Polygon.

60. In any Triangle A B C, one of it's Legs, as B C, being produced towards D, the external Angle A C D is equal to both the internal oppoſite ones taken together, *viz.* to A B C and B A C. In order to prove this, through C draw C E parallel to A B; then ſince the Lines A C and B D croſs thoſe Parallels, the Angle E C D is equal to A B C (by the 37th,) and the Angle A C E equal to C A B (by the 36th ;) therefore the Angles E C D and E C A are equal to the Angles A B C and C A B; but the Angles E C D and E C A are together equal to the Angle A C D; therefore the Angle A C D is equal to both the Angles A B C and C A B taken together.



Cor.

J. F. Armstrong



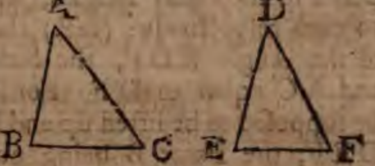
Cor. Hence it may be proved, that if two Lines A B and C D, be croſſed by a third Line E F, and the alternate Angles A E F and E F D be equal, the Lines A B and C D will be parallel; for if they are not parallel they muſt meet one another on one Side of the Line E F (ſuppoſe at G) and ſo form the Triangle E F G, one of whoſe Sides G E being produced to A, the exterior Angle A E F muſt (by this Article) be equal to the Sum of the two Angles E F G and E G F, but, by Suppoſition, it is equal to the Angle E F G alone; therefore the Angle A E F muſt be equal to the Sum of the two Angles E F G and E G F, and at the ſame Time equal to the Angle E F G alone, which is abſurd, ſo the Lines A B and C D cannot meet, and therefore muſt be parallel.

61. In any Triangle A B C, the three Angles taken together are equal to two right Angles. In order to prove this produce B C, one of it's Legs, to any Diſtance, ſuppoſe to D; then by the laſt Propoſition, the external Angle, A C D, is equal to the Sum of the two internal oppoſite ones C A B and A B C; to both add the Angle A C B, then the Sum of the Angles A C D and A C B, will be equal to the Sum of the Angles C A B and C B A and A C B. But the Sum of the Angles A C D and A C B is equal to two right ones (by the 32d,) therefore the Sum of the three Angles C A B, C B A, and A C B is equal to two right Angles; that is, the Sum of the three Angles of any Triangle A C B is equal to two right Angles.

Cor. 1. Hence in any Triangle, if one of it's Angles be known, the Sum of the other two is alſo known: for ſince by the laſt, the Sum of all the three is equal to two right Angles, or a Semicircle, it is plain, that taking any one of them from a Semicircle or 180 Degrees, the Remainder will be the Sum of the other two. Thus (in the former Triangle A B C) if the Angle A B C be 40 Degrees, by taking 40 from 180 we have 140 Degrees; which is the Sum of the two Angles B A C, A C B, the converſe of this is alſo plain, *viz.* The Sum of any two Angles of a Triangle being given, the other Angle is alſo known by taking that Sum from 180 Degrees.

2. In any right-angled Triangle, the two acute Angles muſt juſt make up a right one between them; conſequently, any one of the oblique Angles being given, we may find the other by ſubtracting the given one from 90 Degrees, which is the Sum of both.

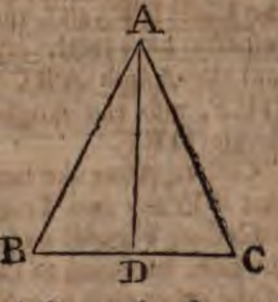
62. If in the Triangles, A B C, D E F, two Legs of the one, be equal to two Legs in the other, each to each reſpectively, *i.e.* A B to D E and A C to D F; and if the Angles included between the equal Legs be equal, *viz.* the Angle B A C equal to the Angle E D F; then I ſay, that the remaining Leg of the one ſhall be equal to the remaining Leg of the other, *viz.* B C to E F; and the Angles oppoſite to equal Legs ſhall be equal, *viz.* A B C equal to D E F (being oppoſite to the equal Legs A C and D F) alſo A C B equal to D F E (which are oppoſite to the equal Legs A B and D E.) For if the Triangle A B C be ſuppoſed to be lifted up and put upon the Triangle D E F, and the Point A on the Point D; it is plain ſince B A and D E are of equal Length, the Point E will fall upon the Point B; and ſince the Angles B A C, E D F are equal, the Line



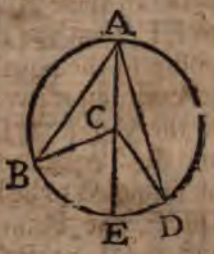
A C will fall upon the Line D F, and they being of equal Length, the Point C will fall upon the Point F, and ſo the Line B C will exactly agree with the Line E F, and the Triangle A B C will in all reſpects be exactly equal to the Triangle D E F; and the Angle A B C will be equal to the Angle D E F, alſo the Angle A C B will be equal to the Angle D F E.

Cor. 1. After the ſame Manner it may be proved, that if in any two Triangles A B C, D E F, (ſee the preceding Figure) two Angles A B C and A C B, of the one, be equal to two Angles D E F and D F E of the other each to each reſpectively (*viz.*) the Angle A B C to the Angle D E F, and the Angle A C B equal to the Angle D F E, and the Sides included between theſe Angles be alſo equal, (*viz.*) B C equal to E F, then the remaining Angles and the Sides oppoſite to the equal Angles, will alſo be equal each to each reſpectively; (*viz.*) the Angle B A C equal to the Angle E D F, the Side A B equal to D E, and A C equal to D F: For if the Triangle A B C be ſuppoſed to be lifted up and laid upon the Triangle D E F, the Point B being put upon the Point E, and the Line B C upon the Line E F, ſince B C and E F are of equal Lengths, the Point C will fall upon the Point F; and ſince the Angle A C B is equal to the Angle D F E, the Line C A will fall upon the Line F D, and by the ſame Way of Reaſoning, the Line B A will fall upon the Line E D, and therefore the Point of Interſection of the two Lines B A and C A, (*viz.*) A will fall upon the Point of Interſection of the two Lines E D and F D, (*viz.*) D, and conſequently B A will be equal to D E, and A C equal to D F, and the Angle B A C equal to the Angle E D F.

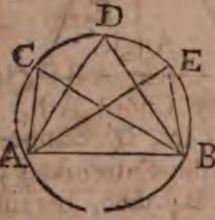
Cor. 2. It follows likewiſe from this Article, that if any Triangle A B C, has two of it's Sides A B and A C equal to one another, the Angles oppoſite to theſe Sides will alſo be equal, (*viz.*) the Angles A B C and A C B. For let A D, biſecting the Angle B A C, meet B C in D, then A D will divide the whole Triangle B A C into two Tringles, A B D and A C D, wherein B A and A D, two Sides of the one, are equal to C A and A D, two Sides of the other, each to each reſpectively; and the included Angles B A D and D A C are, by Suppoſition, equal: Therefore (by this Article) the Angle A B D muſt be equal to the Angle A C D.



63. An Angle, B A D, at the Circumference of a Circle B A D E, is but Half the Angle B C D at the Center, ſtanding on the ſame Arch B E D. To demonſtrate this, draw through A and the Center C, the right Line A C E, then the Angle E C D is equal to both the Angles D A C and A D C (by the 60th;) but ſince A C and C D are equal (being Radii of the ſame Circle) the Angles ſubtended by them muſt be equal alſo (by *Art.* 62. *Cor.* 2.) *i. e.* the Angle C A D equal to the Angle C D A: Therefore D A C and A D C together is double to C A D; and therefore E C D is alſo double D A C. In the ſame Manner it may be proved, that E C B is double C A B, and conſequently the Angle B C D double to the Angle B A D, or B A D the Half of B C D, which was to be proved.

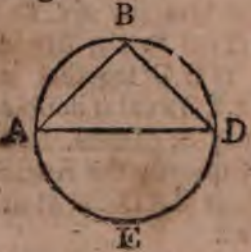


Cor. I. Hence an Angle at the Circumference is meaſured by Half the Arch it ſubtends, for the Angle at the Center (ſtanding on the ſame Arch) is meaſured by the whole Arc (by the 30th;) but ſince the Angle at the Center is double that at the Circumference, it is plain the Angle at the Circumference muſt be meaſured by only Half the Arch it ſtands upon.



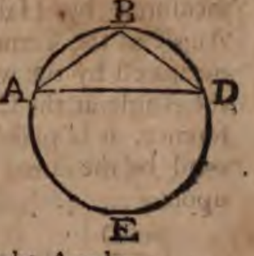
Cor. 2. Hence all Angles, A C B, A D B, A E B, *&c.* at the Circumference of a Circle, ſtanding on the ſame Chord A B, and in the ſame Segment, are equal to one another: For they are all meaſured by the ſame Arc, *viz.* Half the Arc A B, by the laſt Corollary.

Cor. 3. Hence an Angle in a Segment greater than a Semicircle, is leſs than a right Angle: Thus if A D B be a Segment greater than a Semicircle (ſee the laſt Figure) then the Arch A B, on which it ſtands, muſt be leſs than a Semicircle, and the Half of it leſs than a Quadrant, or a right Angle; but the Angle A D B in the Segment, is meaſured by the Half of A B; therefore it is leſs than a right Angle.

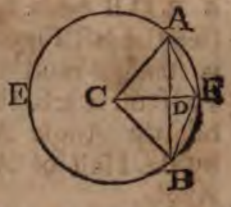


Cor. 4. An Angle in a Semicircle is a right Angle. For A B D being a Semicircle, the Arc A E D muſt alſo be a Semicircle; but the Angle A B D is meaſured by Half the Arc A E D, that is, by Half a Semicircle, or a Quadrant: Therefore the Angle A B D is a right one.

Cor. 5. An Angle in a Segment leſs than a Semicircle, is greater than a right Angle: For ſince the Arch ABD is leſs than a Semicircle, the Arch AED muſt be greater than a Semicircle, and its Half greater than a Quadrant; therefore the Angle ABD, which is meaſured by Half the Arch AED, is greater than a right Angle.



64. From the Center C of a Circle ABE, let fall the Perpendicular CD on the Chord AB, it ſhall biſect that Chord in the Point D. To demonſtrate this: From the Center to the Extremities of the Chord draw the Radii CA, CB; then, becauſe CA and CB are equal, the Angles CAB, CBA, which they ſubtend, muſt be equal alſo; (by *Art.* 62. *Cor.* 2.) but the Perpendicular CD divides the Triangle ACB into two right-angled Triangles, ACD and CDB, in which the Sum of the Angles ACD and CAD in the one, is equal to the Sum of the Angles DCB and CBD in the other, each being equal to a right Angle (by *Cor.* 2. of *Art.* 61.) but CAD is equal to CBD; therefore ACD is equal to BCD. So in the two Triangles ACD and BCD, the two Legs AC and CD in the one, are equal to the two Legs BC and CD in the other, each to each reſpectively, and the included Angles ACD and BCD are equal: Therefore the remaining Legs AD and BD are equal (by the 62d) and conſequently AB biſected in D.



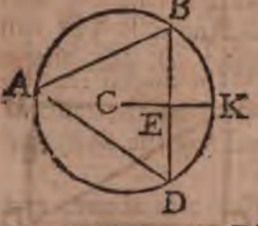
65. The Perpendicular CD drawn as above, and produced till it meets the Circle in F, will biſect the

Arch A B in the Point F: For (ſee the foregoing Figure) join the Points A F and F B, then in the Triangles ADF, BDF, A D is equal to D B (by the laſt) and D F common; therefore A D and D F, in the Triangle A D F, are equal to B D and D F, in the Triangle B D F, and the included Angles A D F, B D F are equal, being both right; therefore (by the 62d) the remaining Legs A F and F B are equal; but in the ſame Circle equal Lines are Chords of equal Arches, conſequently the Arches A F, F B are equal, and the whole Arch A F B biſected in the Point F.

Cor. 1. From the 64th it follows, that a Line biſecting a Chord at right Angles is a Diameter: For (by the 64th) a Line drawn from the Center, perpendicular to a Chord, biſects that Chord at right Angles: Therefore, converſely, a Line biſecting a Chord at right Angles, muſt paſs through the Center, and conſequently be a Diameter.

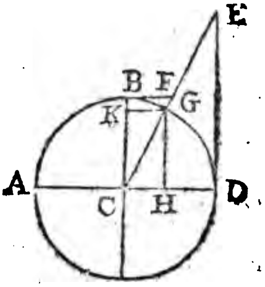
Cor. 2. From the two laſt it follows, that the Sine of any Arc is Half the Chord of twice that Arc; (ſee the foregoing Scheme) A D is the Sine of the Arc A F, by the Definition of a Sine, and the Arc A F is Half the Arc A F B; alſo A D is Half the Chord A B (by the 64th;) therefore the *Corollary* is plain.

66. In any Triangle, the Half of each Side is the Sine of the oppoſite Angle: For ſuppoſe a Circle be drawn through the three angular Points A, B, and D, of the Triangle A B D; then is the Angle D A B meaſured by Half the Arch B K D (by *Cor.* 1. of *Art.* 63.) but Half the Chord B D, *viz.* B E, is the Sine of B K, Half the Arch B K D (by *Cor.* 2. of the laſt) which Half is the

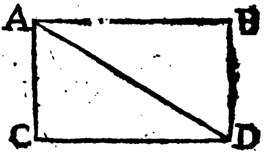


the Meaſure of the Angle B A D: Therefore Half of B D is the Sine of the Angle B A D. The ſame Way it may be proved, that Half A D is the Sine of the Angle A B D, and that Half A B is the Sine of the Angle A D B.

67. The Sine, Tangent, &c. of any Arch, is called alſo the Sine, Tangent, &c. of the Angle meaſured by that Arch: Thus becauſe the Arch G D is the Meaſure of the Angle GCD, and ſince GH is the Sine, DE the Tangent, H D the verſed Sine, C E the Secant, GK the Co-Sine, B F the Co-Tangent, and C F the Co-Secant, &c. of the Arch GD; then GH is called the Sine, DE the Tangent, &c. of the Angle GCD, whoſe Meaſure is the Arch G D.



68. If two equal and parallel Lines, A B, C D, be joined by two other Lines, A C and B D; then theſe ſhall alſo be equal and parallel. To demonſtrate this, join the oppoſite angular Points A and D with the right Line A D; this Line A D divides the Quadrilateral, A C D B, into two Triangles, *viz.* A B D, A C D, in which A B, a Leg of the one, is equal to D C, a Leg of the other, by Suppoſition, and A D is common to both Triangles; and ſince A B is parallel to C D, the Angle B A D will be equal to the Angle A D C (by *Art.* 36.) therefore in the two Triangles B A, A D, and the Angle B A D, are equal to C D, D A, and the Angles A D C: That is, two Legs and the included Angle in the one, is equal to two Legs and the included Angle in the other; therefore (by the 62d) B D is equal to A C; and ſince the Angle D A C



is equal to the Angle A D B, the Lines B D, A C, are parallel (by *Cor. Art.* 60.)

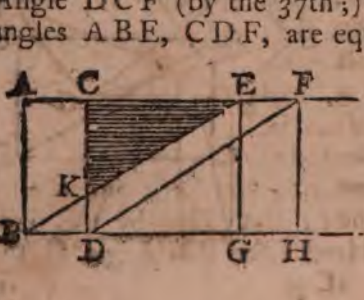
Cor. 1. Hence it is plain, that the Quadrilateral A B D C is a Parallelogram, ſince the oppoſite Sides are parallel.

Cor. 2. In any Parallelogram, the Line joining the oppoſite Angles (called the Diagonal) as A D, divides the Figure into two equal Parts; for it has been proved that the Triangles A B D, A C D, are equal to one another.

Cor. 3. It follows alſo, that a Triangle A C D, on the ſame Baſe C D, and between the ſame Parallels, with a Parallelogram A B D C, is Half of that Parallelogram.

Cor. 4. Hence it is plain, that the oppoſite Sides of a Parallelogram are equal: For it has been proved, that A B D C being a Parallelogram, A B will be equal to C D, and A C equal to B D.

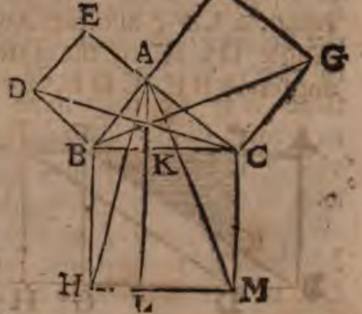
69. All Parallelograms on the ſame, or equal Baſes, and between the ſame Parallels, are equal to one another: That is, if B D and G H be equal, and the Lines B H and A F parallel, then the Parallelograms A B D C, B D F E, and E F H G, are equal to one another: For A C is equal to E F, each being equal to B D (by *Cor.* 4. of 68;) to each add C E, then A E will be equal to C F. In the Triangles A B E, C D F, A B, a Leg of the one, is equal to C D, a Leg in the other, and A E is equal to C F; alſo the Angle B A E is equal to the Angle D C F (by the 37th;) therefore the two Triangles A B E, C D F, are equal (by the 62d;) and taking the Triangle C K E from both, the Figure A B K C will be equal to the Figure K D F E; to both which add the little Triangle K B D,



K B D, then will the Parallelogram A B D C be equal to the Parallelogram B D F E. The ſame Way it may be proved, that the Parallelogram E F H G is equal to the Parallelogram E F D B; ſo the three Parallelograms A B D C, B D F E, and E F H G, will be equal to one another.

Cor. Hence it is plain, that Triangles on the ſame Baſe, and between the ſame Parallels, are equal, ſince they are the Half of the Parallelograms on the ſame Baſe and between the ſame Parallels (by *Cor.* 3. of laſt *Art.*)

70. In any right-angled Triangle, A B C, the Square B C M H, made upon the Hypothenuſe, is equal to the Sum of the Squares made on the two Sides A B and A C, *viz.* to A B D E and A C G F. To demonſtrate this: From the Point A let fall A K L perpendicular to the Hypothenuſe B C, draw A H, A M, D C, and B G; then becauſe D B is equal to B A, alſo B H to B C (by the 54th) the two Legs D B and B C in the Triangle D B C, are equal to the two Legs A B and B H in the Triangle A B H, and the included Angles D B C and A B H are alſo equal; (for D B A is equal to C B H, each being right; add A B C to both, then D B C will be equal to A B H) therefore the Triangles D B C, A B H, are equal (by the 62d,) but the Triangle D B C is Half the Square A B D E (by *Cor.* 3. of 68th) and the Triangle A B H Half the Parallelogram B K L H (by the ſame;) therefore Half the Square A B D E is equal to Half the Parallelogram B K L H. Conſequently the Square A B D E is equal to the Parallelogram B K L H.



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'tis plain the Sine, Tangent, *&c.* of every Arc muſt conſiſt of ſome Number of theſe equal Parts, and by computing them in Parts of the Radius, we may form Tables of the natural Sines, Tangents, *&c.* to every Arch in the Quadrant, and the Logarithms of theſe give us Tables of Logarithmic Sines, Tangents, *&c.*

To underſtand the Nature of which, and the Method of uſing them, you muſt know that Logarithms are only artificial Numbers, contrived to avoid long Operations in natural Numbers, each of which has a Logarithm belonging to it. Their Nature is ſuch, that Addition of them anſwers to Multiplication in natural Numbers, and Subtraction anſwers to Diviſion; that is, when two Numbers are propoſed to be multiplied into one another, if we take the Logarithms anſwering to the Numbers and add them together, the Sum will be the Logarithm anſwering to the natural Number, which is the Product of the two Numbers propoſed.

Again, when one Number is propoſed to be divided by another, if from the Logarithm of the Dividend we ſubtract the Logarithm of the Diviſor, the Remainder ſhall be the Logarithm of the Quotient.

Now to apply this to Practice: The firſt Table at the End of this Book, contains the Logarithms of all the natural Numbers from 1 to 10,000; the Columns marked at the Top with (*N*) contain thoſe Numbers, and the adjacent Columns their Logarithms; ſo that to find the Logarithm of any Integer Number between 1 and 10,000, we muſt look in the Columns marked *N* at the Top, 'till we find the Number propoſed; and that ſtanding on the ſame Line with it in the adjacent Column is the Logarithm required.

Example. Let it be required to find the Logarithm of 365; by looking in the Table according to the above Direction, I find it to be 2.56229. The Reverſe of this, *viz.* Given a Logarithm, to find from the Tables the natural Number anſwering thereto, is performed by looking into the Columns marked with Logarithm at Top, for which one is either equal, or neareſt ſo to the propoſed one, and the Number anſwering to it in the adjacent Column is the Number required.

Example. Let it be required to find the natural Number anſwering to the Logarithm 2.56229, by proceeding according to the above Direction I find it to be 365.

Again, if it were required to find the Logarithm of a mixt Number; in order to do this, you may obſerve in the Table of Logarithms, that the Logarithm of 10 is 1, that of 100, 2; and of 1000, 3, *&c.* and the Logarithms of all the intermediate Numbers between 10 and 100, have 1 for the integral Part of each, and all thoſe between 100 and 1000 have two for the integral Part, and ſo on, which are called their Indices.

Now becauſe any mixt Number conſiſting of both Integers and Decimals, is equal to the Quotient of the whole conſidered as an Integer divided by the Denominator of the decimal Part; and ſince Subtraction by Logarithms, anſwers to Diviſion in natural Numbers; it follows, that the Logarithm anſwering to ſuch mixt Number may be obtained in the following manner: *viz.* Find the Logarithm of the whole conſidered as an Integer; from which take the Logarithm of the Denominator of the decimal Part, or (which is the ſame) from the Index of the Logarithm of the whole conſidered as an Integer, ſubtract a Number leſs by Unity than the Number of Places in the Denominator of the Fraction, and the Remainder will be the Index, which muſt be prefixed in the Room of that belonging to the Logarithm of the whole when conſidered as an Integer, to have the Logarithm of the mixt Number propoſed.

Example 1. Suppoſe you were to find the Logarithm of 36.5; to do this you muſt firſt look for the Logarithm of 365, which is 2.56229; then becauſe 10 is the Denominator of the decimal Part of the propoſed Number, and 1.00000 it's Logarithm, therefore from 2.56229 take 1.00000, and there remains 1.56229 the Logarithm required.

Example 2. And to find the Logarithm of 6.543. Firſt find the Logarithm of 6543 conſidered as an Integer, which by the Tables you will find to be 3.81578; then ſince 3.00000 is the Logarithm of 1000 the Denominator of the fractional Part, therefore from 3.81578 take 3.00000, and there will remain 0.81578, which is the Logarithm required.

The Reverſe of this, *viz.* the Logarithm of a Number conſiſting of Integers and Decimals being given; to find that Number, is performed according to the following Method.

Rule. Look in your Table of Logarithms (without regarding the Indices) for that whoſe decimal Part is equal, or nearly equal to the decimal Part of the Logarithm propoſed; then ſubtract the Index of the former from that of the latter; and laſtly divide the Number anſwering the Logarithm found in your Tables, by a Number conſiſting of an Unit, and as many Cyphers as there are Units in the Difference between the two Indices; or, which is the ſame, cut off as many Figures (beginning at the loweſt Place) of the Number anſwering to the Logarithm in your Table, as there are Units in the Difference of the Indices, and the Number laſt found will be that required.

Example. Suppoſe it were required to find the Number anſwering to the Logarithm 2.73608.

In order to do this, I look in the Table of Logarithms (without regarding the Indices) for that whoſe decimal Part is equal, or nearly ſo to .73608, the decimal Part of the Logarithm propoſed, and I find it to be 3.73608; from the Index of which, *viz.* 3, I take 2, the Index of the propoſed Logarithm, and there remains 1; laſtly, I divide 5446, the Number anſwering the Logarithm found in the Tables, by 10, and the Quotient 544.6 is the Number required.

The Reaſon of this and the preceding Rule, is plain from the Nature of Logarithms.

From what has been ſaid on this Head we may eaſily reſolve the following Problems by the Logarithms, *viz.*

Prob. 1. Two Numbers, as 25.6 and 134, being given to find the Product of their Multiplication; to do this by the Logarithms, I firſt look for the Logarithm of 25.6 which I find to be 1.40824, then for that of 134 which is 2.12710; theſe two Logarithms added together, gives 3.53534, which is the Logarithm of their Product; and the Number in the Tables anſwering to 3.53534, I find to be 3430, which is nearly equal to the Product of 25.6 by 134.

Again, if it were required to find the Product of 36 into 234, the Operation would be as follows:

2.36922 the Logarithm of 234
1.55630 the Logarithm of 36

Sum 3.92552 the Logarithm of their Product

which, by the Table, I find to be 8424, and is the exact Product of the Numbers propoſed.

Prob. 2. Let it be required to find the Quotient that ariſes by dividing one Number by another, ſuppoſe 828 by 23.

To perform this by the Logarithms, I firſt look in the Tables for the Logarithm of 828, the Dividend, and find it to be 2.91803; then for the Logarithm of 23, the Diviſor, which is 1.36173, this laſt taken from the former Logarithm, there remains 1.55630 the Logarithm of the Quotient, which anſwers to the Number 36 the Quotient required.

Again, let it be required to divide 3055 by 47; by proceeding according to the laſt Example, we ſhall have

3.48501 the Logarithm of 3055 the Dividend,
1.67210 the Logarithm of 47 the Diviſor,

1.81291 the Logarithm of the Quotient,

the Number anſwering to which is 65, the Quotient required.

Prob. 3. Three Numbers being given to find a fourth proportional to them, *viz.* Such a Number as ſhall have the ſame Proportion to the third as the ſecond has to the firſt.

Rule. Take from the Tables the Logarithm of each of the propoſed Numbers, then add the Logarithms of the ſecond and third together, and from the Sum take the Logarithm of the firſt, and the Remainder ſhall be the Logarithm of the fourth Number required.

Example. Let the propoſed Numbers be 36, 48, and 66, to which we are to find a fourth proportional; by the preceding Rule, the Operation will ſtand as follows:

1.68124 the Logarithm of 48 the 2d Term,
1.81954 the Logarithm of 66 the 3d Term,

3.50078 the Logarithm of their Product,
1.55630 the Logarithm of the 1ſt Term, 36,

1.94448 the Log. of the 4th Term required, which, by looking into the Tables, I find anſwers to the natural Number 88, and is the 4th proportional to the three propoſed Numbers.

Again, let it be required to find a fourth proportional to the Numbers 24, 144, and 123; by proceeding according to the foregoing Rule, the Operation will ſtand as follows:

2.15836 the Logarithm of the 2d Term 144.
2.08991 the Logarithm of the 3d Term 123.

4.24827 the Logarithm of their Product,
1.38021 the Logarithm of the 1ſt Term 24.

2.86806 the Log. of 738, the 4th Number required.

Prob. 4. To find the Square of any Number by Logarithms.

Rule. Multiply the Logarithm of the given Number by 2, and the Product is the Logarithm of the Square ſought.

Example. Required to find the Square of 36. Firſt I look in the Table for the Logarithm of 36, and find it to be 1.55630, which doubled, gives 3.11260 the Logarithm of the Square ſought, which I find anſwers to the natural Number 1296 the Square of 36, *viz.* the Product of 36 multiplied into itſelf.

Prob. 5. To extract the ſquare Root of any propoſed Number, *i. e.* to find a Number which multiplied into itſelf, ſhall produce the given Number.

Rule. Divide the Logarithm of the propoſed Number by 2, and the Quotient will be the Logarithm of the ſquare Root required.

Example. Required the ſquare Root of 1296. Firſt I look in the Tables for the Logarithm of 1296, and find it to be 3.11260, which divided by 2 gives 1.55630 for the Logarithm of the ſquare Root, and the natural Number anſwering thereto is 36 the Root required.

If for the Sine, Tangent, *&c.* of every Degree and Minute in the Quadrant, in the natural Tables, we take the Logarithm agreeing to each, we ſhall have a Table of Logarithmic Sines, Logarithmic Tangents, *&c.* ſuch is the ſecond Table at the End of this Book.

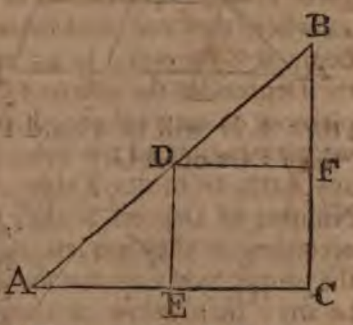
In which you may obſerve, that each Page is divided into eight Columns, the firſt and laſt of which contain Minutes, and the intermediate ones the Sines, Tangents, and Secants; the upper and lower Columns contain Degrees; the Column of Minutes on the left Hand of each Page, anſwers to the Degrees in the Top Column; and the Sines, Tangents, and Secants, belonging to theſe Degrees and Minutes, are in the Columns marked at the Top with the Words, Sine, Tangent, Secant; the Column of Minutes on the right Hand of each Page, anſwers to the Degrees in the foot of the Page, and the Sines, Tangents, and Secants, anſwering to theſe Degrees and Minutes, are in the Columns marked at the Bottom with the Words, Sine, Tangent, Secant; the Degrees in the Top Column beginning at 0, proceed to 44 where they end, and thoſe at the Foot of the Page begin at 89 proceed to 45 in the decreaſing Series, the Degrees in the different Columns being the Complement of each other. From what has been ſaid, we may eaſily find the Sine, Tangent, or Secant, of any Arch, from our Tables, by looking for the given Number of Degrees at the Head or Foot of the Page, according as they are leſs or greater than 45, and in the proper Side Column for the odd Minutes, if there be any; then below or above the Word, Sine, Tangent, or Secant, and on the ſame Line with the Minutes, we ſhall have that required.

Example 1. Required to find the Sine of 36 *deg.* 40 *min.* To find this, I look at the Head of the Page for 36 *deg.* and in the ſide Column on the Left-hand for 40 *min.* then below the Word Sine, and on the ſame Line with 40, I find 9.77609, which is that required.

Example 2. To find the Tangent of 54 *deg.* 30 *min.* I look at the Foot of the Page (becauſe the Degrees propoſed are greater than 45) for 54 *deg.* and in the right-hand ſide Column for 30 *min.* then in the Column marked with Tangent at it's Bottom, and on the ſame Line with the 30 *min.* in the ſide Column, I find 10.14673, which is the Tangent required.

The Reverſe of this, *viz.* to find the Arch of a given Sine, Tangent, or Secant, is performed by only looking in the proper Column for the neareſt Sine, Tangent, &c. to that propoſed, and the Degrees and Minutes anſwering thereto is the Arch required.

The Secants might have been omitted in the Table, becauſe all the Proportions in which the Secants are concerned may be wrought without them, by the Sines and Tangents only, as ſhall be ſhewn particularly in the Solution of the ſeveral Caſes of plane Trigonometry.



72. In any Triangle, A B C, if one of it's Sides, A C, be biſected in E, and through E be drawn E D, parallel to BC, and meeting A B in D; then will B C be double E D, and A B double A D. Through D draw D F, parallel to A C, meeting B C in F: Then, becauſe by Conſtruction D F is parallel to A C, and D E parallel to B C, the Angle B F D

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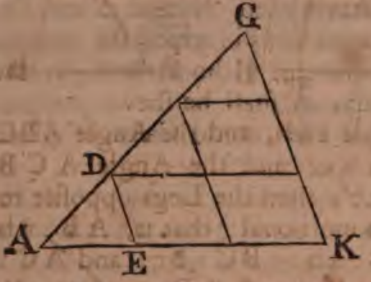
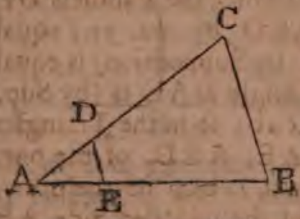
will be equal to the Angle BCA, and the Angle BCA to the Angle DEA (by *Art.* 37.) conſequently the Angle BFD will be equal to the Angle DEA; and (by the ſame Article) the Angles BDF, DAE, will be alſo equal. Now ſince DF is parallel to EC, and DE to FC, DFCE will be a Parallelogram; and therefore (by *Art.* 60. *Cor.* 4.) DF will be equal to EC, which, by Conſtruction, is equal to AE. So in the Triangles BDF, DAE, we have two Angles, BFD, BDF, and the included Side DF, in the one, equal to two Angles, DEA, DAE, and the included Side AE, in the other, each to each reſpectively: Therefore (by *Art.* 62. *Cor.* 1.) AD will be equal to DB, and conſequently AB double AD; alſo (by the ſame) DE will be equal to BF; but DE is alſo (by *Art.* 68. *Cor.* 4.) equal to FC; therefore BF and EC together, or BC, will be double to DE.



After the ſame Manner it may be proved, that if in the Triangle AKG, AE be a third Part of AK, and through E, ED be drawn parallel to KG, meeting AG in D; then ED will be a third Part of GK, and AD a third Part of AG.

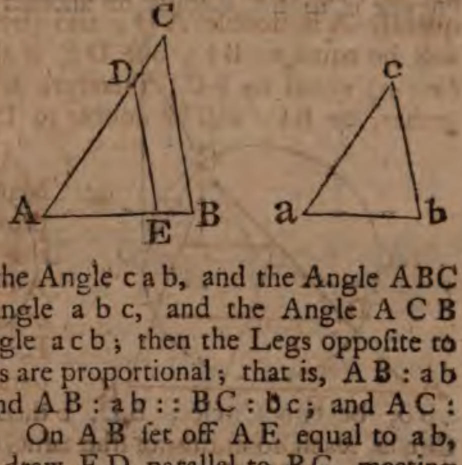


Likewiſe if in any Triangle ABC, AE, be one fourth, one fifth, one ſixth, &c. of AB, and through E be drawn ED, parallel to BC, meeting AC in D; then will DE be the one fourth, one fifth, one ſixth, &c. of BC, and

AD the like Part of AC. In general, if in any Triangle ABC, there be aſſumed a Point E, in one of it's Sides AB, and through that Point be drawn a Line ED, parallel to one of it's other Sides, as BC, meeting the remaining Side AC in D; then whatever Part AE is of AB, the ſame Part will ED be of BC, and AD of AC.

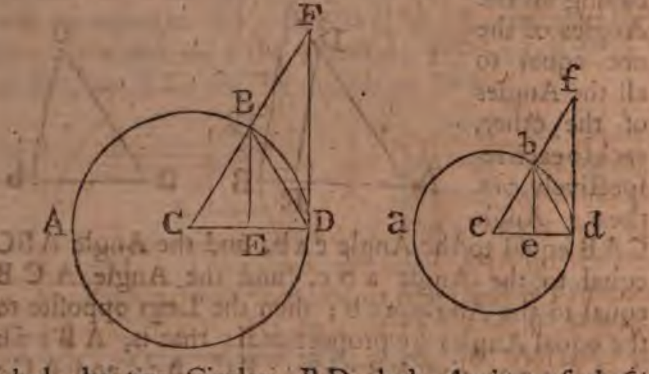
Cor. Hence it follows, that if in any Triangle ABC, there be drawn ED, parallel to one of it's Sides BC, and meeting the other two in the Points E and D, then AE : AB : : ED : BC : : AD : AC; that is, AE is to AB, as ED is to BC, and as AD to AC.

73. If any two Triangles, ABC, abc, are ſimilar, that is, having all the Angles of the one equal to all the Angles of the other, each to each reſpectively, *viz.* the Angle CAB equal to the Angle cab, and the Angle ABC equal to the Angle abc, and the Angle ACB equal to the Angle acb; then the Legs oppoſite to the equal Angles are proportional; that is, AB : ab : : AC : ac; and AB : ab : : BC : bc; and AC : ac : : BC : bc. On AB ſet off AE equal to ab, and through E draw ED parallel to BC, meeting AC in D; then will AB, croſſing the Parallels DE and BC, make the Angle AED (by *Art.* 37.) equal to the Angle ABC, which (by Suppoſition) is equal to the Angle abc, alſo the Angle DAE is (by Suppoſition) equal to the Angle cab; ſo in the Triangles AED, abc, the Angles DAE, AED, of the one, are equal to the Angles cab, abc, of the other, each to each reſpectively, and the included Side AE is (by Conſtruction) equal to the included Side ab; therefore (by *Art.* 62. *Cor.* 1.) AD is equal to ac,



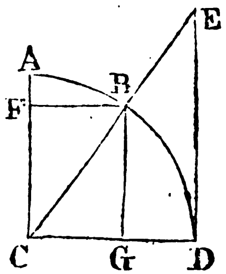
and DE equal to cb: But ſince in the Triangle ABC, DE is drawn parallel to BC, one of it's Sides, meeting the two others Sides in the Points D and E, therefore (by *Cor. Art.* 72.) AB : AE : : AC : AD, and AB : AE : : BC : DE, and AC : AD : : BC : DE, and in the three laſt Proportions, inſtead of the Lines AE, DE, and AD, putting their Equals ab, bc, and ac, we ſhall have AB : ab : : AC : ac, and AB : ab : : BC : bc, and laſtly, AC : ac : : BC : bc.

74. The Chord, Sine, Tangent, *&c.* of any Arch in one Circle, is to the Chord, Sine, Tangent, *&c.* of the ſame Arch in another, as the Radius of the one is to the Radius of another. Let ABD, abd, be two Circles, BD, bd, Arches of theſe Circles, each conſiſting of the ſame Number of Degrees; FD, fd, the Tangents, BD, bd, the Chords, BE, be, the Sines, *&c.* of theſe Arches BD, bd, CD, and cd, the Radii of the Circles; then I ſay, CD : cd : : FD : fd, and CD : cd : : BD : bd, and CD : cd : : BE : be, *&c.* For ſince the Arches BD, bd, are equal, the Angles BCD, bcd, will be equal, and FD, fd, being Tangents to the Points D and d, the Angles CDF, cdf, will be equal, being each a right Angle (*Art.* 23.) ſo that in the Triangles CDF, cdf, two Angles, FCD, CDF, of the one, being equal to the two Angles fcd, cdf, of



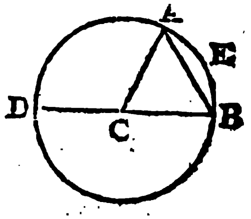
of the other, each to each, the remaining Angle C F D, will be equal to the remaining Angle c f d. (by *Art.* 61.) therefore the Triangles C F D, c f d, are ſimilar, and conſequently (by *Art.* 73.) C D : c d : : F D : f d. In the ſame Manner it may be demonſtrated, that C D : c d : : B D, b d, and C D : c d : : B E : b e, *&c.*

75. Let A B D be a Quadrant of a Circle deſcribed by the Radius C D; B D an Arch of it, and conſequently B A it's Complement, B G equal C F the Sine, C G equal B F the Co-Sine, D E the Tangent, and C E the Secant of that Arch B D. Then ſince the Triangles C D E, C G B, are ſimilar, it will be (by *Art.* 73.) D E : E C : : G B : B C, *i. e.* the Tangent of any Arch, is to the Secant of the ſame, as the Sine of it is to the Radius. Alſo ſince D E : E C : : G B : B C, therefore by inverting that Proportion we have E C : D E : : B C : G B, *i. e.* the Secant of an Arch is to the Tangent, as the Radius is to the Sine of that Arch.



Again, ſince the Triangles C D E, C G B, are ſimilar, therefore (by *Art.* 73.) it will be C D : C E : : C G : C B, *i. e.* as the Radius is to the Secant of any Arch, ſo is the Co-Sine of that Arch to the Radius. And by inverting the Proportion we have this, *viz.* As the Secant of any Arch is to the Radius, ſo is the Radius to the Co-Sine of that Arch.

76. In all Circles the Chord of 60 is always equal to the Radius. Thus in the Circle A E B D, if the Arch A E B be 60 Degrees, then drawing the Chord A B, I ſay A B ſhall be equal to the Radius C B or A C; for in the Triangle A C B, the An-



gle ACB is 60 Degrees, being meaſured by the Arch AEB; therefore the Sum of the other two Angle is 120 Degrees (by *Cor.* 1. of 61ſt) but ſince AC and CB are equal, the two Angles CAB, CBA, will alſo be equal, conſequently each 60 Degrees; hence all the three Angles are equal to one another, conſequently all the Legs, therefore AB is equal to CB.

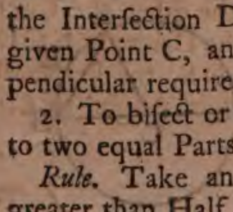
Cor. Hence the Radius from which the Lines on any Scale are formed, is the Chord of 60 on the Line of Chords.

Having thus gone through the Theorems in *Geometry*, that are neceſſary for the Knowledge of *Navigation*, we ſhall next proceed to ſome Problems that are uſeful for the Practice of that Art.

GEOMETRICAL PROBLEMS.

Prob. 1. FROM a Point C, in a given Line AB, to raiſe a Perpendicular to that Line.

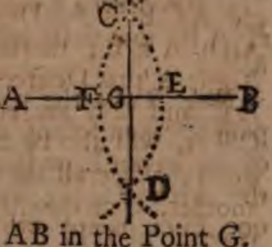
Rule. From the Point C take the equal Diſtances CB, CA, on each Side of it; then ſtretch the Compaſſes to any Diſtance greater than CB or CA, and with one Foot of them in B, ſweep the Arch EF with the other; again, with the ſame Opening, and one Foot in A, ſweep the Arch GH with the other; join the Interſection D of theſe two Arches with the given Point C, and the Line CD ſhall be the Perpendicular required.



2. To biſect or divide a given right Line AB, into two equal Parts.

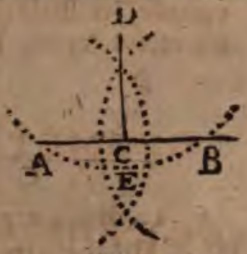
Rule. Take any Diſtance with your Compaſſes greater than Half the given Line; then ſetting one

Foot of them in B, with the other ſweep the Arch DFC; and with the ſame Diſtance, and one Foot in A, with the other ſweep the Arch CED; the Interſections C, D, of theſe Arches, being joined by the right Line DC, will biſect AB in the Point G.



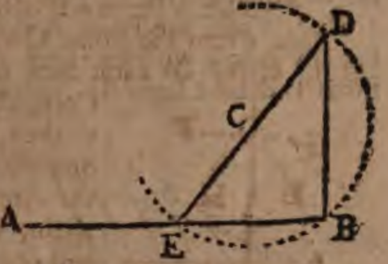
3. From a given Point D, to let fall a Perpendicular on a given Line AB.

Rule. Set one Foot of the Compaſſes in the Point D, extend the other to any Diſtance greater than the leaſt Diſtance between the given Point and the Line, and with that Extent ſweep the Arch AEB, cutting the Line in the Points A and B, then (by the laſt Problem) biſect the Line AB in the Point C, laſtly join the Points C and D, then will CD be the Perpendicular required.



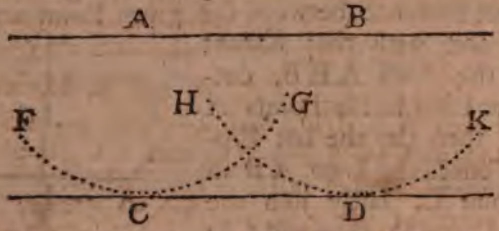
4. Upon the End B of a given right Line BA, to raiſe a Perpendicular.

Rule. Take any Extent in your Compaſſes, and with one Foot in B fix the other in any Point C, above the given Line, then with one Point of the Compaſſes in C, deſcribe with the other the Circle EBD; through E and C draw the Diameter ECD, meeting the Circle in D; draw DB, the Perpendicular required; for EBD is a right Angle (by *Cor.* 4. of 63.)

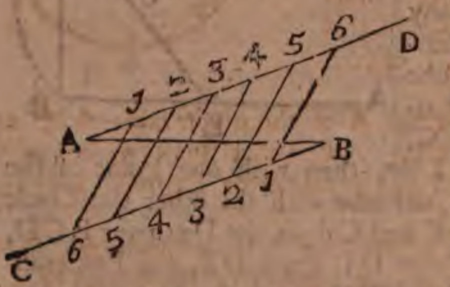


5. To draw a Line parallel to another given Line, as A B, that ſhall be any given Diſtance D, from it.

Rule. Take the given Diſtance D, in your Compaſſes; then ſetting one Foot of them in any Point of the given Line (ſuppoſe A) with the other ſweep the Arch F C G; again, at the ſame Extent, and one Foot in any other Point of the given Line B, ſweep the Arch H D K, and draw the Line C D touching theſe Arches, which will be parallel to the given Line A B, and diſtant from it by a Line equal to D, as was required.



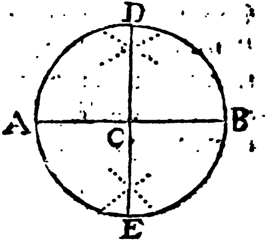
6. To divide a given Line A B, into any Number of equal Parts, ſuppoſe 7.



Rule. From the Point A draw a Line A D, making any Angle with the Line A B, then through the Point B draw a Line B C, parallel to A D. From A, with any ſmall Opening of the Compaſſes, ſet off a Number of equal Parts (on the Line A D) leſs by one than the propoſed Number (here 6, the propoſed Number being 7;) then from B ſet off the ſame Number of thoſe Parts on the Line B C; laſtly, join 1 and 6, 2 and 5, 3 and 4, 4 and 3, 5 and 2, 6 and 1, and theſe Lines will cut the given Line as required.

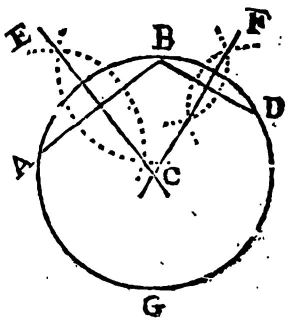
7. To quarter, or divide, a given Circle into four equal Parts.

Rule. Through the Center C of the given Circle draw A B, then upon the Point C raiſe a Perpendicular DCE, to the Line AB; and theſe Diameters, A D and D E, ſhall quarter the Circle.



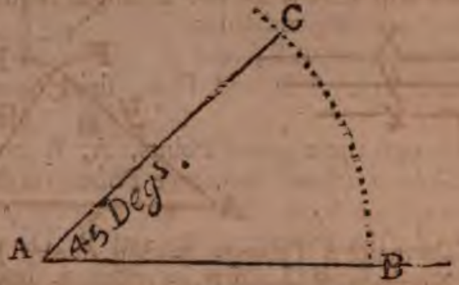
8. Through three given Points, A, B, and D, to draw a Circle. (*Note*, the three Points muſt not lie in the ſame ſtrait Line.)

Rule. Join the Points A, B, and B, D, with the ſtrait Lines AB, BD, then by *Prob.* 2. biſect AB and BD with the Lines FC and EC, theſe Lines will cut one another in C, the Center of the Circle required; then fixing one Point of your Compaſſes in C, and ſtretching the other to A, deſcribe the Circle ABDG, which will paſs thro' the three Points given. The Reaſon of this is plain from *Cor.* 1. of *Art.* 65.



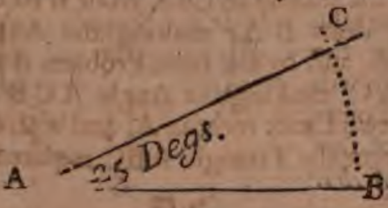
9. From the Point A of the given Line AB, to draw another Line AC, that ſhall make with AB an Angle of any Number of Degrees, ſuppoſe 45.

Rule. Let the given Line AB be produced, then take off your Scale the Length of the Chord of 60 Degrees, which is equal to the Radius of the Circle the Scale was made for (by *Art.* 76.) and ſetting one Foot in A, with the other ſweep the Arch B C; then with your Compaſſes take from your Scale the Chord of 45 Degrees, and ſet off that Diſtance from B to C; laſtly join A and C, and the Line A C is that required: For the Angle C A B, which is meaſured by the Arch B C, is an Angle of 45 Degrees, as was required.



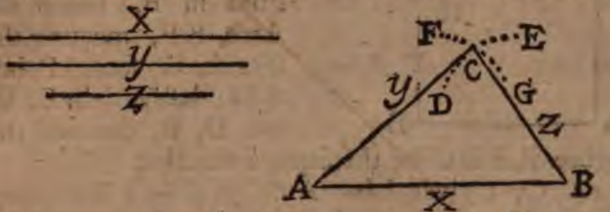
10. An Angle B A C being given, to find how many Degrees it contains.

Rule. With your Compaſſes take the Length of the Chord of 60 from your Scale; then ſetting one Foot in A, with the other ſweep the Arch B C, cutting the Legs A B, A C (produced if needful;) laſtly, take with your Compaſſes the Diſtance B C, and applying it to your Line of Chords on the Scale, you will find how many Degrees the Arch B C contains, and conſequently the Degrees of the Angle B A C, which was required.



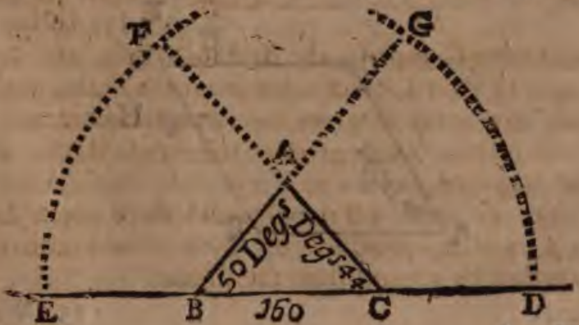
11. To form a Triangle with three given Lines, *x*, *y*, and *z*, provided the Sum of any two taken together be greater than the third.

Rule. Make any one of them, as *x*, the Baſe; then with your Compaſſes take another of them, as *z*, and ſetting one Foot in one End of the Line *x*, as B, with the other ſweep the Arch D E. Take with your Compaſſes the Length of the other *y*, and ſetting one Foot in A, with the other ſweep the Arch F G, cutting the former in C; laſtly, join C A and C B, then will C A B be the Triangle required.



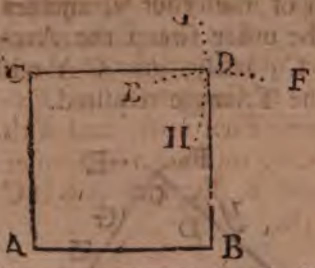
12. To make a Triangle having one of it's Legs of any Number of equal Parts (ſuppoſe 160) one of the Angles adjacent to that Leg 50 Degrees, and the other 44 Degrees.

Rule. Draw an indefinite Line ED, then from the Line of equal Parts take with your Compaſſes 160 of them, which ſet on the indefinite Line, from B to C; then (by *Prob.* 9.) draw B A, making the Angle ABC of 50 Degrees, and by the ſame Problem draw from C the Line A C, making the Angle A C B of 44 Degrees; theſe two Lines meet in A, and will, together with BC, form the Triangle ABC required.



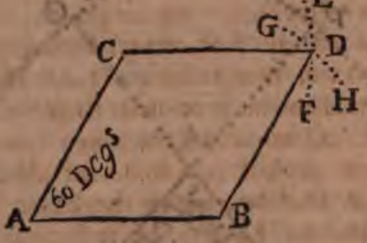
13. Upon a given Line A B, to make a Square.

Rule. Upon the Extremity A of the given Line A B, raiſe a Perpendicular A C (by *Prob.* 4.) and make A C equal to A B; with that Extent, ſetting one Foot of the Compaſſes in C, ſweep the Arch G H with the ſame Extent, and placing one Foot in B, ſweep the Arch E F, meeting the former in ſome Point, as D; laſtly, join C, D, and D, B, then will the Figure A B D C be the Square required.



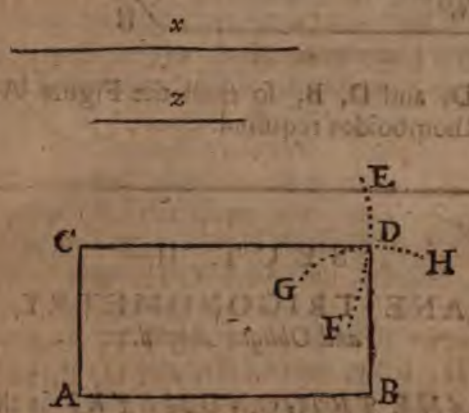
14. On a given Line A B, to draw a Rhombus, that ſhall have one of it's Angles equal to any Number of Degrees, ſuppoſe 60 Degrees.

Rule. From the Point of the given Line A B, draw the Line A C, making the Angle C A B of 60 *Deg.* (by *Prob.* 9.) Take A C equal to A B, with that Extent fixing one Foot of the Compaſſes in B, with the other deſcribe the Arch G H, and with the ſame Extent fixing one Foot of the Compaſſes in C, with the other deſcribe the Arch E F, cutting the former in D; laſtly, join C, D, and D, B, and the Figure A C D B is that required.



15. With two given Lines, *x* and *z*, to make a Rectangle.

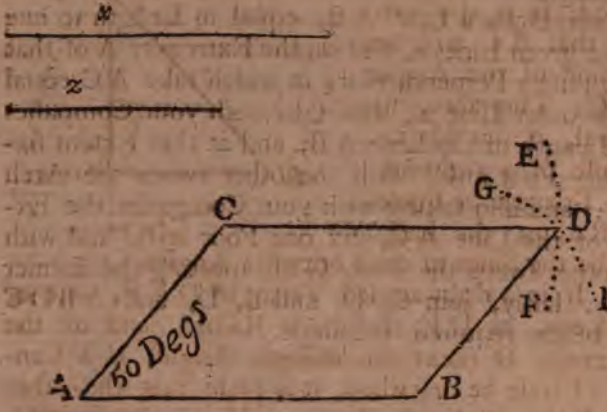
Rule. Draw a Line A B, equal in Length to one of the given Lines *x*, and on the Extremity A of that Line raiſe a Perpendicular, in which take A C equal to the other Line *z*; then take with your Compaſſes the Length of the Line A B, and at that Extent fixing one Foot in C, with the other ſweep the Arch E F; and alſo taking with your Compaſſes the Extent of the Line A C, fix one Foot in B, and with the other ſweep the Arch G H, meeting the former in D; laſtly, join C, D, and B, D, and A B D C will be the required Rectangle.



16. Two Lines, *x* and *z*, being given, of theſe to form a Rhomboides that ſhall have one of it's Angles any Number of Degrees, ſuppoſe 50.

Rule. Draw a Line A B, equal in Length to one of the Lines, as *x*, then draw the Line A C, making B A C equal to the propoſed Angle of 50 Degrees; make A C equal to the given Line *z*, then take the Length of A B in your Compaſſes, and fixing one Foot in C, ſweep with the other the Arch E F; alſo with the Length of A C in your Compaſſes, and one Foot in B, with the other ſweep the

Arch G H, cutting the former in D; then



join C, D, and D, B, ſo ſhall the Figure A B D C be the Rhomboides required.

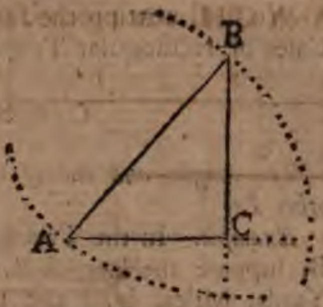
SECT. II.

Of PLANE TRIGONOMETRY, *Right and Oblique Angled.*

1. *PLANE TRIGONOMETRY* is that Science by which we meaſure the Sides and Angles of plane Triangles.

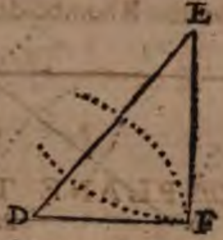
2. Since Triangles are either right or oblique angled, therefore Trigonometry is commonly divided into two Kinds, *viz.* *Rectangular* and *Oblique-angular*: And firſt we ſhall treat of Rectangular.

3. In any right-angled Triangle A B C, if the Hypothenuſe be made the Radius, and with that a Circle be deſcribed on the one End A, as a Center, then it is plain that B C will be the Sine of the Angle B A C (by *Art.* 21. of *Sect.* I.) and if with the ſame Diſtance,



Diſtance, on B as a Center, a Circle be deſcribed, it is alſo evident that A C will be the Sine of the Angle A B C: Therefore, in general, if the Hypothenuſe of a right-angled Triangle be made the Radius, the Legs will be the Sines of their oppoſite Angles.

4. If in a right-angled Triangle D E F, one of the Legs, as D F, be made Radius, and on the Extremity D (next the oblique Angle) as a Center, a Circle be deſcribed, it is plain that the other Leg E F, will be the Tangent of the Angle at D, and the Hypothenuſe D E, the Secant of the ſame Angle (by *Art.* 24, 25, 67, of *Sect.* I.) The ſame Way, making the Leg E F Radius, and on the Center E deſcribing a Circle, the other Leg D F, will become the Tangent of the Angle at E, and the Hypothenuſe D E, the Secant of the ſame.



5. It has been already ſhewn (at *Art.* 74. of *Sect.* I.) that the Chord, Sine, Tangent, &c. of any Angle in one Circle, is proportionable to the Chord, Sine, Tangent, &c. of an equal Angle in any other Circle; from which, and the two foregoing Articles, the Solutions of the ſeveral Caſes of rectangular Trigonometry naturally follow.

6. Since Trigonometry conſiſts in determining Angles and Sides from others given, there will ariſe various Caſes, which are ſeven in rectangular, and ſix in oblique-angular Trigonometry.

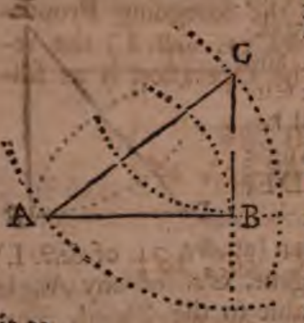
We ſhall now proceed to the Solution of the ſeven Caſes of rectangular Trigonometry.

CASE I.

The Angles and one of the Legs given, to find the other Leg.

Example. In the Triangle A B C, right-angled at B, ſuppoſe the Leg A B, 86 equal Parts (as Feet, Yards, Miles, *&c.*) and the Angle at A 33°, 40′, required the other Leg B C, in the ſame Parts with A B.

Geometrically.



Draw A B equal to 86, from any Line of equal Parts, then (by *Prob.* 4. of *Sect.* I.) upon the Point B erect the Perpendicular B C; laſtly, from the Point A draw the Line A C, making with A B an Angle equal to 33°, 40′, and that Line produced will meet B C in C, and ſo conſtitute the Triangle. The Length of B C may be found by taking it in your Compaſſes, and applying it to the ſame Line of equal Parts from whence A B was taken.

By Calculation.

Firſt, By making the Hypothenuſe A C Radius, the other Legs will be the Sines of their oppoſite Angles (by *Art.* 3. of this) *viz.* A B the Sine of C, and C B the Sine of A; now ſince (by *Art.* 74. of *Sect.* I.) the Sine, Tangent, *&c.* of any Angle in one Circle is proportionable to the Sine, Tangent, *&c.* of the ſame Angle in any other Circle, it follows that the Sines of the Angles A and C in the Circle whoſe Radius is A C, muſt be proportional to the Sine of the ſame Angles, in the Circle, that the ſecond Table at the End of this Book is calculated for; therefore to find B C we have this Proportion;

S, C : A B :: S, A : B C;

i. e. as the Sine (in the Tables) of the Angle C is to the Length of A B, ſo is the Sine of the Angle A (in the ſame Tables,) to the Length of B C.

Now the Angle A being 33°, 40′, the Angle C muſt be 56°, 20′ (by *Art.* 61. *Cor.* 2. *Sect.* I.) therefore looking in the ſecond Table at the End of this Book for the Sines of thoſe Angles, and in the firſt for the Logarithm of 86 the given Leg, we ſhall find by proceeding according to the foregoing Proportion, (and by *Prob.* 3. in *Art.* 71. *Sect.* I.) the required Leg B C, 57.28. The Operation is as follows:

1.93450	A B	86
9.74380	S, A	33°, 40′
11.67830		
9.92027	S, C	56°, 20′
1.75803	B C	57.28

2*dly*, Make A B Radius, then will B C, the required Leg become the Tangent of the given Angle A (by the 4th of this,) and the Proportion for finding B C, will be,

R : T, A :: A B : B C;

i. e. as the Radius of the Tables, is to the Tangent of the Angle A therein, ſo is the Length of B A, to the Length of B C; therefore looking in the Tables for the Parts given in the foregoing Proportion, and proceeding with them according to that Rule, we ſhall find B C to be 57.28 as before, the Operation being as follows:

9.82352	T, A	33°, 40′
1.93450	A B	86
11.75802		
10.00000	Rad.	90°
1.75802	B C	57.28

Laſtly, making B C, the required Leg, Radius, 'tis plain that A B will be the Tangent of C, and the Proportion for finding B C will be as follows:

T, C : R :: A B : B C;

i. e. as the Tangent of C	56°, 20′	10.17648
is to Radius or Sine of -	90° -	10.00000
ſo is the Length of A B -	86 - -	1.93450
		11.93450
		10.17648
to the Length of B C -	57.28 -	1.75802

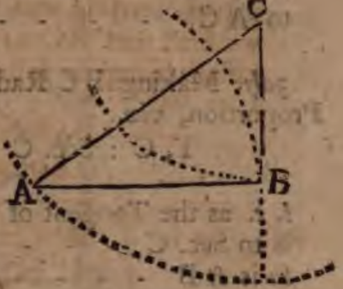
CASE 2.

The Angles and one of the Legs given, to find the Hypothenuſe.

Example. In the Triangle A B C, ſuppoſe A B 124, and the Angle A 34°, 20′; conſequently the Angle C 55°, 40′, required the Hypothenuſe A C, in the ſame Parts with A B.

Geometrically.

Geometrically.



This Caſe is conſtructed after the ſame Manner with the former, the Hypothenuſe A C being found by taking its Length in your Compaſſes, and applying that Length to the ſame Line of equal Parts you took A B from.

By Calculation.

1*ſt*, By making A C Radius we ſhall have the following Proportion for finding A C, *viz.*

S, C : R :: A B : A C;

i. e. as the Sine of C	55°, 40′	9.91686
is to Radius or Sine of -	90° -	10.00000
ſo is A B - -	124 - -	2.09342
to A C - -	150.2 - -	2.17656

2*dly*, Making A B Radius we have this Proportion, *viz.*

R : Sec. A :: A B : A C;

i. e. as Radius - - - - -		10.00000
is to the Secant of A -	34°, 20′ -	10.08314
ſo is A B - - - -	124 -	2.09342
to A C - - - - - -	150.2 -	2.17656

This may be done without the Help of the Secants; for ſince (by *Art.* 75. *Sect.* I.) R : Sec. :: Co-S : R; therefore the former Proportion will become

Co-S, A : R :: A B : A C,

i. e. as the Co-Sine of A	34°, 20' -	9.91686
is to the Radius - - - - - -		10.00000
ſo is A B - - - - -	124 -	2.09342
to A C - - - - - -	150.2 -	2.17656

3dly, Making B C Radius, we have the following Proportion, *viz.*

T, C : Sec. C :: A B : A C;

i. e. as the Tangent of C	55°, 40'	10.16558
is to Sec. C, - - - -	55°, 40'	10.24872
ſo is A B - - - - -	124 -	2.09342
to A C - - - - - -	150.2 -	2.17656

This may alſo be done without the Help of Secants, for ſince (by *Art.* 75. *Sect.* I.) T, : Sec. :: S, : R; therefore the former Analogy will be reduced to this, *viz.*

S, C : R :: A B : A C,

where no Secants appear; and as it coincides with that in the firſt Suppoſition of this Caſe, ſo we need not repeat the Operation.

CASE 3.

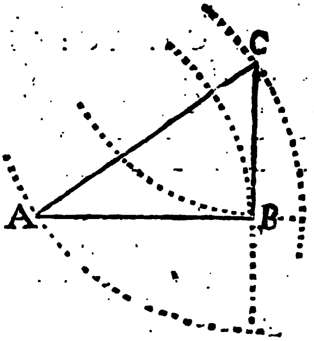
The Angles and Hypothenuſe given, to find either of the Legs.

Example. In the Triangle A B C, ſuppoſe the Hypothenuſe A C 146 equal Parts, and the Angle A 36°, 25', conſequently the Angle C 53°, 35', required the Leg A B.

Geometrically.

Draw the Line A B at Pleaſure, and make the Angle B A C equal to 36°, 25', (by *Prob.* 9. *Sect.* I.) then take A C equal to 146 from any Line of equal

Parts; laſtly, from the Point C let fall the Perpendicular C B on the Line A B. So the Triangle is conſtructed, and A B may be meaſured from the Line of equal Parts.



By Calculation.

1*ſt*, Making A C Radius we ſhall have the following Proportion, *viz.*

R : S, C : : A C : A B;

i. e. as Radius - - - -		10.00000
is to the Sine of C - -	53°, 35′	9.90565
ſo is A C - - - - - -	146 - -	2.16435
to A B - - -	117.5 - -	2.07000

2*dly*, Making A B Radius, we have the following Analogy, *viz.*

Sec. A : R : : A C : A B;

i. e. as the Secant of A -	36°, 25′	10.09435
is to Radius - - - -		10.00000
ſo is A C - - -	146 -	2.16435
to A B - - - - -	117.5 -	2.07000

This may be done without the help of Secants, for ſince (by *Art.* 75. *Sect.* I.) Sec. : R : : R : Co-S; therefore the former Proportion may be reduced to this, *viz.*

R : Co-S, A :: A C : A B

which is the ſame with the Proportion in the firſt Suppoſition.

3dly, By ſuppoſing B C Radius, we have the following Proportion, *viz.*

Sec. C : T, C :: A C : A B;

i. e. as the Secant of C	53°, 35′	10.22647
is to the Tangent of C	53°, 35′	10.13212
ſo is A C - - - - -	146 -	2.16435
to A B - - - - - -	117.5 -	2.07000

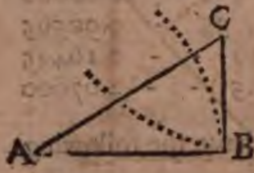
CASE 4.

The two Legs being given, to find the Angles.

Example. In the Triangle A B C, ſuppoſe A B 94 and B C 56, required the Angles A and C.

Geometrically.

Draw A B equal to 94, from any Line of equal Parts, then from the Point B raiſe B C, perpendicular to A B (by *Prob.* 4. *Sect.* I.) and take B C, from the former Line of equal Parts equal to 56; laſtly, join the Points A and C with the ſtrait Line A C, ſo the Triangle is conſtructed, and the Angles may be meaſured by *Prob.* 10. *Sect.* I.



By Calculation.

1ſt, Suppoſing A B Radius, we have this Analogy, *viz.*

A B : B C :: R : T, A;

i. e. as A B - - -	94 - -	1.97313
is to B C - - - -	56 - -	1.74819
ſo is the Radius - -	- - -	10.00000
to the Tangent of A	30°, 47′ - -	9.77506

2*dly*, Making BC the Radius, we have this Proportion, *viz.*

BC : BA :: R : T, C;

i. e. as BC - - -	56 - - -	1.74819
is to AB - - - - -	94 - - -	1.97313
ſo is the Radius or Sine of	90° - - -	10.00000
to the Tangent of C -	59°, 13′ -	10.22494

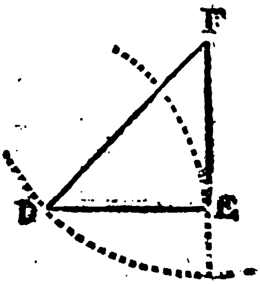
CASE 5.

The Hypothenuſe, and one of the Legs given, to find the Angles.

Example. In the Triangle DEF, ſuppoſe the Leg DE 83, and the Hypothenuſe DF 126, required the Angles D and F.

Geometrically.

Draw DE equal to 83, taken from any Scale of equal Parts; at the Point E raiſe the Perpendicular EF, then take the Length of DF 126, from the ſame Scale as before, ſet one Foot of your Compaſſes in D, and with the other croſs the Perpendicular EF in F; laſtly, join D and F, ſo the Triangle is conſtructed, and the Angles may be meaſured by *Prob.* 10. *Sect.* I.



By Calculation.

1*ſt*, Making DF Radius, we have this Proportion, *viz.*

DF : DE :: R : S, F;

i. e. as D F - - - - 126 - - - 2.10037
is to D E - - - - 83 - - - 1.91908
ſo is the Radius - - - - 10.00000
to the Sine of F - - 41°, 12′ - 9.81871

2*dly*, By ſuppoſing D E Radius, we have the following Analogy, *viz.*

D E : D F :: R : Sec. D;

i. e. as D E - - - - 83 - - - 1.91908
is to D F - - - - 126 - - - 2.10037
ſo is the Radius - - - - 10.00000
to the Secant of D - 48°, 48′ - - 10.18129

This may be done without uſing the Secants, for ſince by *Art.* 75. *Sect.* I. R : Sec. :: Co-S, : R; therefore the preceding Analogy will become this, *viz.*

D F : D E :: R : Co-S, D;

which evidently coincides with the Proportion deduced from the firſt Suppoſition, for the right Sine of F is the Coſine of D.

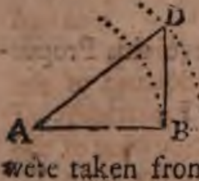
CASE 6.

The Legs being given, to find the Hypothenuſe.

Example. In the Triangle A B D, ſuppoſe the Leg AB, 64, and BD, 56, required the Hypothenuſe AD.

Geometrically.

The Conſtruction of this Caſe is performed in the ſame Manner as the fourth. The Length of the Hypothenuſe AD is meaſured by taking in your Compaſſes that Line, and applying it to the ſame Scale, which the Legs were taken from.



By Calculation.

This Caſe being compounded of the *4th* and *2d* Caſes, we muſt firſt find the Angles by the *4th* thus:

A B : D B :: R : T, A;

i. e. as the Leg A B	64	1.80618
is to the Leg D B	56	1.74819
ſo is the Radius		10.00000
to the Tangent of A	41°, 11′	9.94201

Then by the *2d* Caſe we find the Hypothenuſe required thus:

S, A : R :: BD : AD;

i. e. as the Sine of A	41°, 11′	9.81854
is to the Radius		10.00000
ſo is the Leg B D	56	1.74819
to the Hypothenuſe A D	85.05	1.92965

This Caſe may alſo be ſolved after the following Manner, *viz.*

From twice the Log. of the greater Side A B 3.61236
ſubtract the Log. of the leſſer Side B D - 1.74819

and there remains - - - - - - - - 1.86417
the Logarithm of 73.15; to which adding the leſſer Side BD, we ſhall have 129.15 whoſe Log. is 2.11093
to which add the Log. of the leſſer Side BD 1.74819

and the Sum will be - - - - - - - 3.85912
the Half of which is - - - - - - - 1.92956
the Logarithm of the Hypothenuſe required.

Or it may be done by adding the Squares of the two Sides together, and taking the Logarithm of that Sum, the Half of which is the Logarithm of the Hypothenuſe required; thus in the preſent Caſe:

the Square of A B (64) is - - - - - - 4096
the Square of B D (56) is - - - - - - 3136

the Sum of theſe Squares, is - - - - - 7232
the Logarithm of which, is - - - - - 3.85926
the Half of which, is - - - - - - - 1.92963
the Logarithm of 85.05 the Length of the Hypothenuſe required. - - -

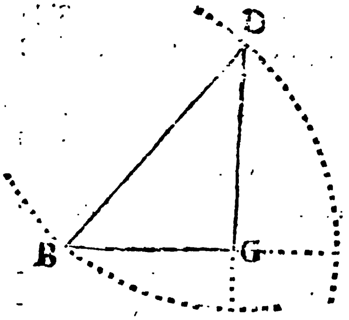
CASE 7.

The Hypothenuſe and one of the Legs given, to find the other Leg.

Example. In the Triangle B G D, ſuppoſe the Leg B G 87, and the Hypothenuſe B D 142, required the Leg D G.

Geometrically.

The Conſtruction here is the ſame as in Caſe 5th, the ſame Things being given; and the Leg D G is found by taking it's Length in your Compaſſes, and applying that to the ſame Scale of equal Parts, the others were taken from.



By

By Calculation.

The Solution of this Caſe depends upon the 1*ſt* and 5*th*, and firſt we muſt find the oblique Angles by Caſe 5*th* thus;

DB : BG : : R : S, D;

i. e. as the Hypoth. DB	- 142	- -	2.15229
is the Leg BG	- - - - 87	- -	1.93952
ſo is Radius	- - - -	-	10.00000
to the Sine of D	- - - 37°, 47′	-	9.78723

Then by Caſe 1*ſt* we find the Leg DG required thus:

R : S, B : : BD : DG;

i. e. as Radius	- - -	-	10.00000
is to the Sine of B	- - 52°, 13′	-	9.89781
ſo is the Hypoth. DB	- 142	- -	2.15229
to the Leg DG	- - 112.2	- -	2.05010

The Leg DG may alſo be found in the following Manner, *viz.*

To the Log. of the Sum of the Hypothenuſe and given Leg, *viz.* 229 -	2.35984
add the Log. of their Difference. *viz.* 55	1.74036
and their Sum is - - - -	4.10020
the Half of that is - - -	2.05010

the Log. of 112.2 the Leg required.

Or it may be done by taking the Square of the given Leg from the Square of the Hypothenuſe, and the ſquare Root of the Remainder is the Leg required thus in the preſent Caſe;

The

The Square of the Hypothenuſe 142, is -	20164
the Square of the Leg B G 87, is - -	7569
their Difference is - - - - -	12595
whoſe Logarithm is - - -	4.10020
half that Logarithm is - - -	2.05010

which anſwers to the Natural Number 112.2 the Leg required.

Thus we have gone thro' the ſeven Caſes of right-angled *Plane Trigonometry*, from which we may obſerve;

1. That to find a Side when the Angles are given, any Side may be made Radius.

2. To find an Angle, one of the given Sides muſt of Neceſſity be made Radius.

We now proceed to the Solution of the ſix Caſes of oblique-angled *Plane Trigonometry*, in order to which we muſt premiſe the following Theorems.

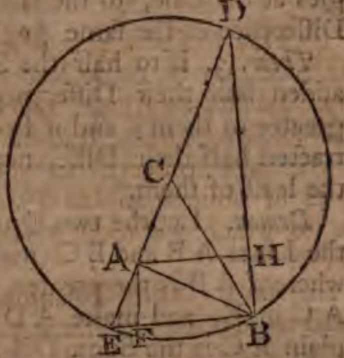
Theorem 1. In any Triangle, the Sides are proportional to the Sines of the oppoſite Angles. Thus in the Triangle A B C, A B : B C : : S, C, : S, A and A B : A C : : S, C : S, B; alſo A C : B C : : S, B : S, A.

Demonſtration. Let the Triangle A B C be circumſcribed with a Circle; then 'tis plain, from *Art.* 66. *Sect.* I. that Half each Side is the Sine of it's oppoſite Angle, to the Radius of the circumſcribing Circle, but (by *Art.* 74. *Sect.* I.) the Sines of theſe Angles in the Tables, are proportional to the Sines of the ſame Angles to any other Radius, therefore in the Triangle A B C, the Sines of the Angles will be as the Halves of their oppoſite Sides; and ſince the Halves are as the Wholes, it follows that the Sines of the

the Angles are as their oppoſite Sides, *i. e.* S, C : S, A :: A B : B C, *&c.*

Theor. 2. In any plane Triangle A B C, it will be as the Sum of any two Sides A C and B C, is to their Difference, ſo is the Tangent of half the Sum of the Angles B A C, A B C, at the Baſe A B, to the Tangent of half the Difference of the ſame Angles.

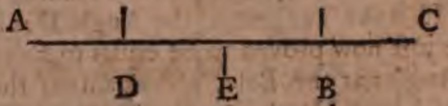
Demon. Upon the Center C with the Side B C as Radius, deſcribe a Circle, meeting C A produced in the Points D and E, draw E B and D B, then will E B D be a right Angle (by *Cor.* 4. *Art.* 63. *Sect.* I.) Draw alſo A H parallel to E B, join the Points A B, draw the Radius C B, and from A let fall A F perpendicular to E B. Now becauſe the Angle D C B is equal to the Sum of the Angles B A C, A B C, at the Baſe, it is evident that the Angle D E B or its equal D A H will be half that Sum, and becauſe the Angle B A C is equal to the Sum of the Angles C E B (or C B E) and A B E, it follows that the Difference between the Angles C A B and C B A will be equal to twice the Angle A B E, conſequently the Angle A B E is half the Difference of the Angles B A C, A B C at the Baſe A B. But to the Radius A H, the Line D H is the Tangent of the Angle D A H, which we have juſt now proved to be equal to half the Sum of the Angles at the Baſe, and again to the Radius B F (equal to A H) A F is the Tangent of the Angle A B F, which in like Manner has been proved equal



equal to half the Difference of the Angles at the Baſe. The Triangles A H D, A E F are ſimilar, and conſequently (by *Art.* 73. *Sect.* I.) A D : A E :: D H : A F or H B; that is A D, the Sum of the Legs A C and C B, is to A E, the Difference of thoſe Legs, as D H the Tangent of half the Sum of the Angles at the Baſe (the Radius being A H) is to B H the Tangent (to the ſame Radius) of half the Difference of the ſame Angles; and therefore (by *Art.* 74. *Sect.* I.) as the tabular Tangent of half the Sum of the Angles at the Baſe, to the tabular Tangent of half the Difference of the ſame Angles.

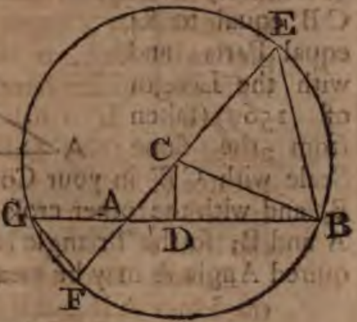
Theor. 3. If to half the Sum of two Quantities be added half their Difference, the Sum will be the greater of them; and if from half their Sum be ſubtracted half their Difference, the Remainder will be the leaſt of them.

Demon. Let the two Quantities be repreſented by the Lines A B and B C (making one continued Line) whereof A B is the greater, and B C the leſs. Biſect A C in E, and make A D equal to B C; then 'tis plain A C is the Sum, D B the Difference of the two Quantities, A E or E C their half Sum, and E D or E B their half Difference. Now if to A E we add E B, the Sum will be A B, that is, if to half the Sum we add the half Difference, the Sum will be the greater Quantity; alſo if from E C we take E B, the Remainder will be B C, that is, if from half the Sum we take half the Difference of two Quantities, the Remainder will be the leaſt of them.



Theor. 4. In any plane Triangle A B C, it will be as the Baſe A B is to the Sum of the Sides A C and B C, ſo is the Difference between thoſe Sides to the Difference between A D and B D the Segments of the Baſe, made by a perpendicular C D falling thereon from the oppoſite Angle C.

Demon. With the longer Side C B as Radius upon the Center C, deſcribe a Circle, meeting the ſhorter Side (produced both Ways) in the Points E and F, and A B produced, in the Point G. Then A E will be the Sum and A F the Difference of the Sides A C, BC. Likewiſe ſince (by *Art.* 64. *Sect.* I.) G D is equal to B D, therefore A G will be the Difference of the Segments A D, B D. Draw the Chords BE, FG. Then in the Triangles B A E, G A F, the Angles A B E, G F A, are equal (by *Cor.* 2. *Art.* 63. *Sect.* I.) and the Angle B A E is equal to the Angle G A F, (by *Art.* 33. *Sect.* I.) therefore the remaining Angles A E B, A G F, muſt be equal, and the Triangles A B E, A G F ſimilar; conſequently (by *Art.* 73. *Sect.* I.) A B : A E :: A F : A G; that is, A B the Baſe is to A E the Sum of the Sides A C and C B, as A F, the Difference of theſe Sides, is to A G, the Difference of the Segments of the Baſe.



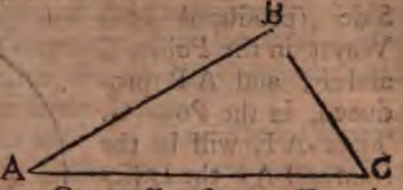
CASE 1.

In any oblique-angled plane Triangle; two Sides, and an Angle oppoſite to one of them, given, to find the Angle oppoſite to the other.

Example. In the Triangle ABC, ſuppoſe AB 156, BC 84, and the Angle C, oppoſite to BA, 56°, 30′; required the Angle A oppoſite to BC.

Geometrically.

Draw the Line AC, and at any Point of it, ſuppoſe C, make the Angle C equal to 56°, 30′ (by *Prob.* 9. *Sect.* I.) take CB equal to 84 equal Parts; and with the Length of 156 (taken from the ſame Scale with CB) in your Compaſſes, fix one Foot in B, and with the other croſs AC in A. Laſtly, join A and B; ſo the Triangle is conſtructed, and the required Angle A may be meaſured by *Prob.* 10. *Sect.* I.



By Calculation.

By *Theorem* 1. we have the following Proportion for finding the Angle A, *viz.*

AB : S, C :: BC : S, A;

i. e. as the Leg AB - -	156° -	2.19312
is to the Sine of it's oppoſite Angle C, 56°, 30′ - - - - -		9.92111
ſo is the Leg BC - - - -	84 -	1.92428
		11.84539
		2.19312
to the Sine of it's opp. Angle A	26°, 41′	9.65227

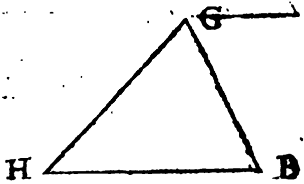
CASE 2.

The Angles, and a Side oppoſite to one of them, given, to find a Side oppoſite to the other.

Example. In the Triangle HBG, are given the Leg HB 125, the Angles at H and B 46°, 15′, and 54°, 22′, reſpectively, the Angle G will then be 79°, 23′; required the Leg HG.

Geometrically.

Draw HB 125, from a Scale of equal Parts; make the Angle H 46°, 15′, and B 54°, 22′, then produce the Lines HG and BG to meet in the Point G; ſo the Triangle is conſtructed, and HG is meaſured by taking it's Length in your Compaſſes, and applying it to the ſame Scale HB was taken from.



By Calculation.

By the firſt of the preceding Theorems, we have this Analogy for finding HG, *viz.*

S, G : HB : : S, B : HG;

i. e. as the Sine of G -	79°, 23′ -	9.99250
is to the Leg HB - -	125 - -	2.09691
ſo is the Sine of B - -	54°, 22′ -	9.90996
to the Leg HG - -	103.4 - -	2.01437

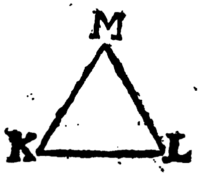
CASE 3.

Two Sides and an Angle oppoſite to one of them given, to find the third Side.

Example. In the Triangle KLM, ſuppoſe the Side KL 126 equal Parts, and KM 130 of the ſame equal Parts, and the Angle L (oppoſite to KM) 63°, 20′, required the Side ML.

Geometrically.

Geometrically.



The Conſtruction of this Caſe is the ſame with *Caſe* 1. (the ſame Things given in both) and the Leg ML muſt be meaſured upon the ſame Scale of equal Parts by which KL and KM were laid down.

By Calculation.

The Solution of this Caſe depends upon the two preceding; and firſt we muſt find the other two Angles by *Caſe* 1. thus:

NK : S, L : : KL : S, M;

i. e. as the Side MK -	130 - -	2.11394
is to the Sine of L - -	63°, 20′. -	9.95116
ſo is the Side KL - -	126 - -	2.10037
to the Sine of M - - -	60°, 1′ -	9.93759

Then by *Caſe* 2. we find the required Leg ML thus:

S, L : MK : : S, K : ML;

i. e. as the Sine of L -	63°, 20′ -	9.95116
is to MK - - - - - -	130 - -	2.11394
ſo is the Sine of K - -	53°, 39′ -	9.90602
to ML - - - - - -	117.2 - -	2.06880

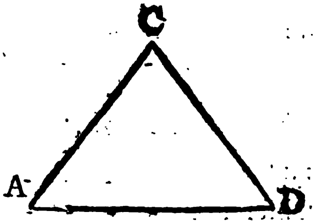
CASE 4.

Two Sides and the contained Angle given, to find the other Angles.

Example. In the Triangle A C D, let A C be 103, A D 126, and the Angle A 54°, 30′, required the Angles C and D.

Geometrically.

Draw A D 126 equal Parts, and make the Angle A 54°, 30′, then ſet 103 equal Parts from A to C, and join the Points C, D, and ſo the Triangle is conſtructed.



The Angles C and D may be meaſured by a Line of Chords.

By Calculation.

The Solution of this Caſe depends upon the ſecond and third of the preceding Theorems; and firſt we muſt find the Sum and Difference of the Sides, and Half the Sum of the unknown Angles, thus:

the Leg A D is	126
the Leg A C is	103
their Sum is	229
and their Difference is	23
the Sum of the three Angles A, D, and C, is	180°
the Angle A is	54°, 30′
ſo the Sum of the Angles C and D will be	125°, 30′
and Half their Sum is	62°, 45′

Then by *Theorem* 2. we have the following Proportion, *viz.*

as the Sum of the Sides AD and AC 229 2.35984
is to their Difference - - - - - - 23 1.36173
ſo is the Tang. of Half the Sum of the unknown Angles - } 62°, 45′ 10.28816
to the Tang. of Half their Diff. 11°, 2′ 9.29005

Now having Half the Sum and Half the Difference of the two unknown Angles C and D, we find the Quantity of each of them by *Theorem* 3. thus:

To Half the Sum of the Angles C and D 62°, 45′
add Half their Difference - - - - - - 11°, 02′

and the Sum is the greater Angle C - 73°, 47′

Again, from Half the Sum - - - - 62°, 45′
take Half the Difference - - - - - - 11°, 02′

and there will remain the leſſer Angle D - 51°, 43′

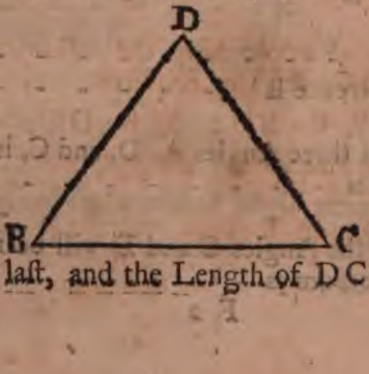
CASE 5.

Two Sides and the contained Angle given, to find the third Side.

Example. In the Triangle BCD, ſuppoſe BC 154, BD 133, and the Angle at B 56°, 03′, required the Side CD.

Geometrically.

The Conſtruction of this Caſe is the ſame with that of the laſt, and the Length of DC is found by taking



taking it's Length in your Compaſſes, and applying it to the ſame Scale of equal Parts that the two Legs were taken from.

By Calculation.

The Solution of this Caſe depends upon the ſecond and fourth; therefore find the Angles by the laſt Caſe, thus:

As the Sum of the Sides BD and BC	287	2.45788
is to their Difference	21	1.32222
ſo is the Tangent of Half the Sum of the Angles D and C	61°, 58′	10.27372
to the Tang. of Half their Diff.	7°, 50′	9.13806

Then by *Theorem* 3. we find the Angles D and C thus:

To Half the Sum of thoſe Angles	61°, 58′
add Half their Difference	7°, 50′
and the Sum is the greater Angle D	69°, 48′
Alſo, from Half their Sum	61°, 58′
take Half their Difference	7°, 50′
and there remains the leſſer Angle C	54°, 08′

Then by *Caſe* 2. we have the following Analogy for finding DC, the Leg required.

S, C : BD : : S, B : DC;

i. e. as the Sine of C	54°, 08′	9.90869
is to BD	133	2.12385
ſo is the Sine of B	56°, 03′	9.91883
to DC	136.2	2.13399

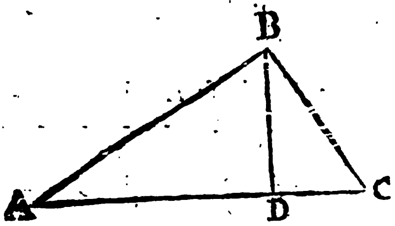
CASE 6.

The Sides being given, to find the Angles.

Example. In the Triangle ABC, ſuppoſe AB 156, BC 84, and AC 185.7; required the Angles A, B, and C.

Geometrically.

Make AC 185.7 from any Scale of equal Parts, and from the ſame Scale taking 156, the Length of AB, in your Compaſſes, fix one Foot in A, and with the other ſweep an Arch; then take 14, the Length of BC, and fixing one Foot in C, with the other ſweep an Arch, croſſing the former in B; join the Points B, A, and C, and the Triangle will be conſtructed. The Angles may be meaſured by a Line of Chords.



By Calculation.

Let fall BD from the Vertex B, perpendicular to the Baſe AC; find the Segments AD and DC, by the following Proportion, deduced from *Theorem* 4. *viz.*

As the Baſe AC - - - - - 185.7 - 2.26893
is to the Sum of the Sides AB and BC 240 - 2.38031
ſo is the Difference of the Sides - 72 - 1.85733

to the Diff. of the Segments of the Baſe 93 - 1.96871

And having the Sum of the Segments, *viz.* the whole Baſe, and their Difference, we find the Segments themſelves, by *Theorem* 3. thus:
To Half the Sum of the Segments - - 92 . 8
add Half their Difference - - - - - - 46 . 5

the Sum is the greater Segment AD - 139 . 3

Alſo from Half the Sum of the Segments - 92 . 8
take Half their Difference - - - - - - 46 . 5

the Remainder is the leſſer Segment DC - 46 . 3

The Triangle ABC is divided by the Perpendicular DB into two right-angled Triangles, ADB, and BDC; in the firſt of theſe are given the Hypothenuſe AB 156, and the Baſe AD 139.3, to find the oblique Angles, for which we have (by *Caſe* 5. of rectangular Trigonometry) the following Analogy, *viz.*
As AB - - - - - - - - - 156 - 2.19312
is to AD - - - - - - - - 139.3 - 2.14395
ſo is Radius - - - - - - - - - - - 10.00000

to the Co-Sine of the Angle A 26°, 40′ - 9.95083

The Angle C is found by the ſame Caſe, thus:
As BC - - - - - - - - 84 - - - 1.92428
is to CD - - - - - - - 46.3 - - 1.66558
ſo is Radius - - - - - - - - - - 10.00000

to the Co-Sine of C - 56°, 30′ - - 9.74130

Having found the Angles A and C, we get the Angle B, by taking the Sum of the two former from 180, thus:

The Sum of all the three Angles is - - 180°,
The Sum of A and C is - - - - 83°, 10′

The Angle B is - - - - - - - - 96°, 50′

All the Proportions uſed in the Solutions of the ſeveral Caſes in *Plane Trigonometry*, may be performed by Scale and Compaſs. On the Scale there are ſeveral Logarithmic Lines, *viz.* one of Numbers, another of Sines, and one of Tangents, *&c.* And to work a Proportion by theſe Lines, extend your Compaſſes from the firſt Term of your Proportion, found on the Scale, to the ſecond, and with that Extent, fixing one Foot in the third Term, the other will reach to the fourth Term required.

SECT. III.

Of the Principles of GEOGRAPHY and ASTRONOMY.

1. THE Land and Water of this Earth make up a Compoſition of a ſpherical Form, or rather an oblate Figure, which is called the *Terraqueous Globe.*

2. This Globe moving round it's Axis in 24 Hours, from Weſt to Eaſt, and thereby cauſing the celeſtial Bodies to revolve apparently from Eaſt to Weſt, in the ſame Time, make the Viciſſitudes of Day and Night.

3. Thoſe two Points in which the Axis of the Earth meets the Surface, are called the Poles of the Earth; and if the Axis be produced on both Sides to the Heavens, it will cut them in two oppoſite Points, called the *Celeſtial Poles*. The one towards the North is called the *Arctic Pole*; and the other towards the South, is termed *Antarctic*.

4. Circles upon a Sphere are either Great or Leſs. A *Great Circle* is that whoſe Plane paſſes through the Center of the Sphere, or whoſe Diameter is equal to the Diameter of the Sphere. A *Leſs Circle* is that whoſe Plane does not paſs through the Center of the Sphere, or whoſe Diameter is leſs than the Diameter of the Sphere.

Cor. 1. Hence it is plain, that all great Circles upon a Sphere divide it equally, and all leſs Circles divide it unequally.

Cor. 2. And ſince all great Circles have the ſame Center, *viz.* that of the Sphere, it is plain they muſt biſect each others Circumference.

5. Since the Earth moves round it's Axis, it is plain that every Point in the Surface (except the Poles, which are at reſt) will deſcribe the Circumference of a Circle; and that which is deſcribed by a Point, lying in the Middle between the two Poles, is called the *Equator*, or *Equinoctial Line*, or ſimply the *Line*.

6. If the Plane of the Equator be produced to the Heavens, it will there mark out a Circle called the *Celeſtial Equator*, which divides the Earth and Heavens into two Hemiſpheres, that towards the North being called the *Northern Hemiſphere*, and that towards the South, the *Southern*.

7. Great Circles paſſing through the Poles of the World, and cutting the Equator at Right Angles, are called *Meridians*; and that which paſſes over any Place, is called the Meridian of that Place.

8. The Diſtance of any Place upon the Earth, from the Equator, counted in Degrees upon the Meridian, is called the *Latitude* of that Place; and it is either North or South, according as it lies upon the North or South Side of the Equator.

9. Since by the Rotation of the Earth about it's Axis, every Point upon it's Surface deſcribes a Circle, it is plain all the Points between the Equator and Poles muſt deſcribe Circles parallel to the Equator; and theſe are called *Parallels of Latitude.*

10. The *Difference of Latitude* between two Places, is the Arch of a Meridian, contained between the Parallels of Latitude paſſing over theſe Places.

Cor. 1. Hence if the two Places lie both on the ſame Parallel, they will have no Difference of Latitude.

Cor. 2. If the Places lie both on the ſame Side of the Equator, and on different Parallels, then their Difference of Latitude is found by taking the leſs Latitude from the greater.

Cor. 3. But if the Places lie on different Sides of the Equator, then their Diſtance in Latitude, is equal to the Sum of the two Latitudes.

11. The *Complement of the Latitude* of any Place, is that Latitude taken from 90 Degrees, or the Diſtance of the Place from the neareſt Pole.

12. The *Longitude* of any Place upon the Earth, is an Arch of the Equator intercepted between the firſt Meridian, and the Meridian paſſing through the propoſed Place: Which is equal to the Angle at the Pole formed by the firſt Meridian, and the Meridian of the Place.

13. The firſt Meridian may be placed at pleaſure, paſſing through any Place, as *London*, *Paris*, *Teneriff*, &c. and the Longitudes counted from it will be either Eaſt or Weſt, according as they lie on the Eaſt or Weſt Side of that Meridian.

14. The *Difference of Longitude* between two Places upon the Earth, is an Arch of the Equator comprehended between the Meridian of thoſe Places, and the greateſt poſſible is 180 Degrees, *viz.* when the two Places lie on oppoſite Meridians.

15. Since by the Motion of the Earth about it's Axis, every Point upon the Surface deſcribes the Circumference of a Circle, or 360 Degrees, in 24 Hours Time, it is plain in one Hour it muſt deſcribe 15 Degrees: Therefore any Place lying 15 Degrees to the Eaſtward of another, has the Sun upon it's Meridian one Hour ſooner than the other; ſo when it is twelve o'Clock in the eaſtermoſt Place, it will be but eleven in the other.

Cor. Hence the Difference of Longitude may be converted into Difference of Time, by allowing 1 Hour for every 15 Degrees, and proportionally for Minutes, *&c.* alſo Difference of Time may be converted into Difference of Longitude, by allowing 15 Degrees for every Hour, and proportionally for other Time. Conſequently, by knowing the one, we can find the other.

16. If we ſuppoſe a Plane touching the Surface of the Earth in any Point (upon which a Spectator is ſtanding) and produced to the Heavens, it will there make a Circle called the *Horizon*, which ſeparates the viſible from the inviſible Part of the Heavens. This Horizon is properly the *ſenſible Horizon*; the *true* or *rational Horizon* is a great Circle parallel to the ſenſible, and paſſing through the Center of the Earth, which divides the Heavens and Earth into Hemiſpheres, one being called the *Upper*, and the other the *Lower Hemiſphere.*

17. Theſe Horizons, when produced to the Heavens, may, without any ſenſible Error, be ſuppoſed to coincide: The Diſtance between them, or the Earth's Semidiameter, vaniſhing when compared with ſuch a Diſtance.

18. Since the Earth moves round it's Axis from Weſt to Eaſt, it is plain a Spectator upon it's Surface, together with his Horizon, muſt move the ſame Way; conſequently, theſe Celeſtial Bodies towards the Eaſt, that were before hid, will become viſible, the Horizon being depreſſed before them; and thoſe towards the Weſt, that were before in View, will become inviſible, the Horizon being elevated above them. And hence ariſes the apparent Motion of all the heavenly Bodies, by which they appear to deſcribe Circles about the Poles, parallel to the Celeſtial Equator, and are greater or leſs according as they are more or leſs diſtant from the neareſt Pole.

19. When any celeſtial Body comes firſt in View, or when it is on the Eaſtern Side of the Horizon, it is then ſaid to *Riſe*; and when by it's apparent Motion it comes to the Meridian, it is ſaid to *Culminate*; and, laſtly, when it begins to diſappear, or is upon the Weſtern Side of the Horizon, it is then ſaid to *Set*.

20. If through the Center of the Earth there be drawn a Line perpendicular to the Plane of the Horizon, and produced to the Heavens, it will there mark out two Points; the one, which is directly over our Heads, is called the *Zenith*; and the oppoſite Point thereto, which is inviſible to us, *viz.* directly under our Feet, is called the *Nadir*.

21. *Vertical* or *Azimuth Circles*, are great Circles paſſing through the Zenith and Nadir, and cutting the Horizon at right Angles. Among the vertical Circles there are two principal ones, *viz.* the Meridian, which paſſes through the Zenith, Nadir, and Poles, and cuts both the Equator and Horizon at right Angles; the Points in which it cuts the Horizon are the South and North Points; and the other principal Vertical, called the *prime Vertical*, is that which cuts the Meridian at right Angles, and meets the

Horizon in two oppoſite Points, called the Eaſt and Weſt Points.

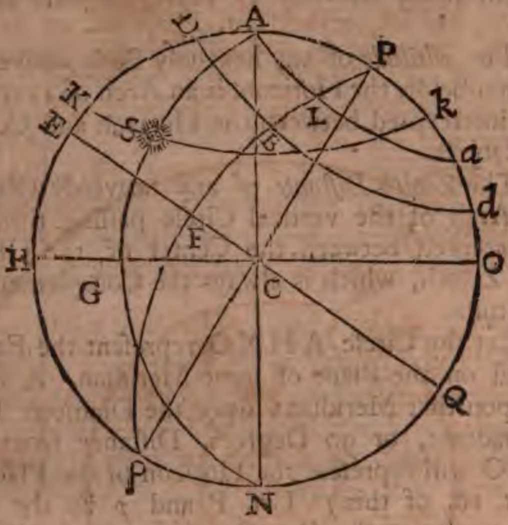
22. Leſſer Circles parallel to the Horizon, are called *Almicanthers*, or *Parallels of Altitude.* And theſe continually decreaſe the nearer they are to the Zenith.

23. The *Altitude* of any heavenly Body above, or Depreſſion below the Horizon, is an Arch of a vertical Circle, intercepted between the Horizon and Center of the Object.

24. The *Zenith Diſtance* of any heavenly Object, is that Arch of the vertical Circle paſſing through it, intercepted between the Center of the Object and the Zenith, which is always the Complement of the Altitude.

25. Let the Circle A H N O repreſent the Earth, projected on the Plane of ſome Meridian, A ſome Place upon that Meridian; draw the Diameter H O at a Quadrant, or 90 Degrees, Diſtance from A; then H O will repreſent the Horizon of the Place A (by *Art.* 16. of this.) Let P and *p* be the two Poles; conſequently P *p* the Axis of the Earth, and the Diameter E Q at right Angles with that, will repreſent the Equator (by *Art.* 5.) make P *a* equal to P A, and draw the Circle A *a* parallel to the Equator E Q, and this will be the Parallel of Latitude the Place A is in; the Arch A E will be the Latitude of the Place A, and A P the Complement of it's Latitude (by *Art.* 8. and 11.) the Point in the Heavens directly above A will be the Zenith, and that directly above N will be the Nadir of the Place A (by *Art.* 20.) the great Circle ACN will be the prime Vertical (by *Art.* 21.) and the Points H and O will be the South and North Points, and C will repreſent the Eaſt and Weſt Points in the Horizon of A. Let S be any heavenly Object, and ASN a vertical or azimuth Circle, paſſing through the Cen-

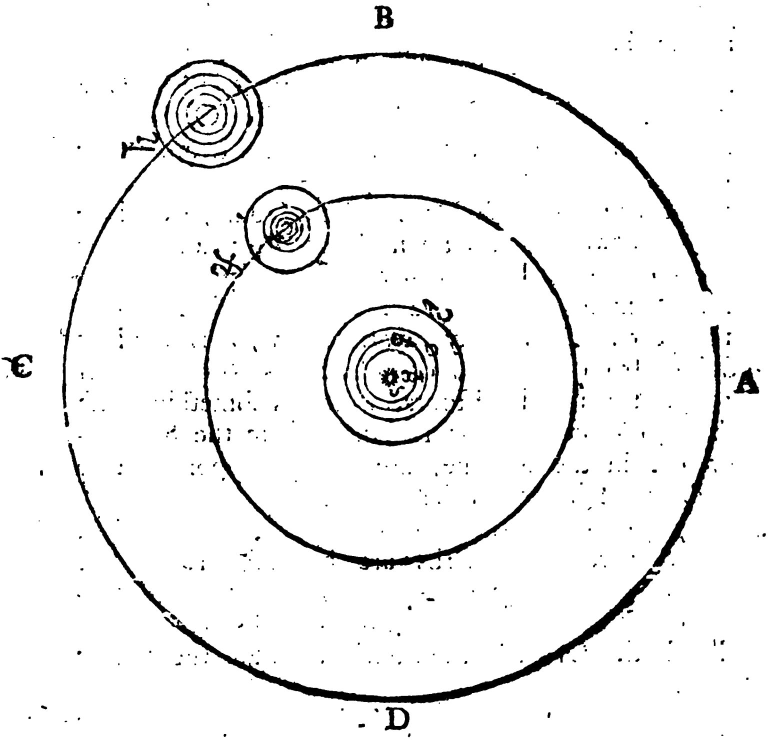
ter of the Object, alſo KS it's Parallel of Altitude; then SG will be the Altitude, and SA the Zenith Diſtance of the Object S (by *Art.* 23 and 24.) A-



gain, let any other Place upon the Earth be aſſumed, as B, and it's Meridian will be P B *p*, and it's Parallel of Latitude D B *d*; then the Latitude of B will be BF or DE, and the Complement of it's Latitude will be BP or DP. Alſo the Difference of Latitude between the two Places A and B, will be BL or DA (by *Art.* 10.) If the Meridian paſſing through A, be ſuppoſed the firſt Meridian, then the Longitude of B will be EF (by *Art.* 12;) but if the Meridian of A be not ſuppoſed the firſt Meridian, then the Difference of Longitude between the two Places A and B will be EF (by *Art.* 14.)

26. The Syſtem of the Univerſe, according to the lateſt Aſtronomers, is as follows, *viz.* The *Sun*

is ſuppoſed to be in the common Center of Gravity of ſix opake ſpherical Bodies, called *Planets*, which are at different Diſtances from the Sun, and perform their ſeveral Periods round him in different Times. The Names of theſe Planets, and the Characters, by which they are expreſſed, are as follow, *viz.* *Mercury* ☿, *Venus* ♀, the Earth ⊖,



Mars ♂, *Jupiter* ♃, and *Saturn* ♄. And they all move round the Sun, from Weſt to Eaſt, in Orbs very little inclined to one another, and the Planes of theſe Orbs cut one another in Lines paſſing through the Center of the Sun; conſequently a

Spectator placed in the Center of the Sun, will be in the Plane of each of their Orbs, and will there view the Planets, performing their ſeveral Periods round him, from Weſt to Eaſt, according to the Order of the Letters A B C D (in the annexed Scheme) and in different Times, *viz.* *Mercury* ☿, which is neareſt the Sun, moves round his Orb in 87 Days and 23 Hours, or three Months nearly. Then *Venus* ♀, which is next to *Mercury*, performs her Period in 224 Days and 17 Hours, or about eight Months. The Planet which is third in Order from the Sun is our Earth ⊖, which performs it's Circuit in 365 Days, 5 Hours, and 49 Minutes, or a Year. Next to the Earth is *Mars* ♂, who moves round his Orb in 686 Days and 23 Hours, or a little leſs than two Years. Then *Jupiter* ♃, whoſe Orb is vaſtly extended beyond that of *Mars*, performs his Circuit in 4332 Days 12 Hours, which is about 12 Years. And laſtly *Saturn* ♄, who is furtheſt diſtant from the Sun, compleats his Revolution in 10759 Days and 7 Hours, which is ſomething leſs than 30 Years. Their Diſtances from the Sun expreſſed in the Scheme, are nearly proportional to their true Diſtance in the Heavens.

27. Three of the Planets, *viz.* *Mars*, *Jupiter*, and *Saturn*, whoſe Orbs are beyond that of the Earth, are called *ſuperior Planets*; and the two Planets *Venus* and *Mercury*, whoſe Orbs are between the Earth's Orb and the Sun, are called the *inferior Planets.*

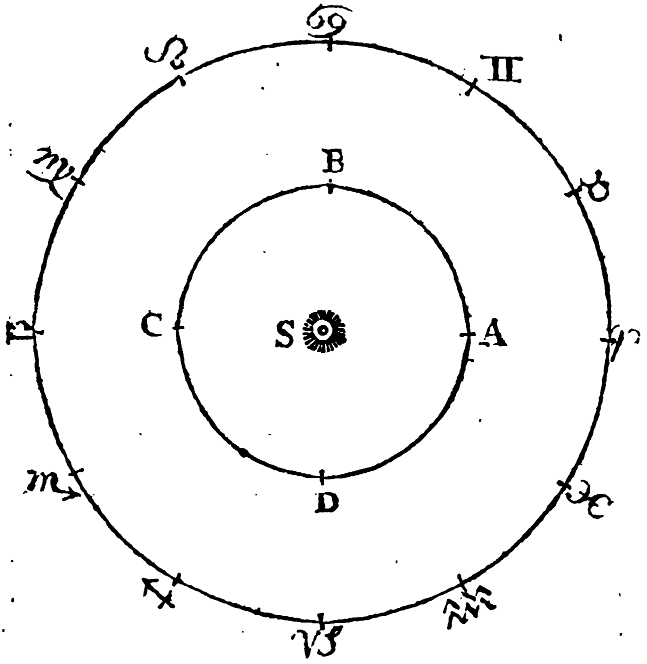
28. The three Planets, *Jupiter*, *Saturn*, and the Earth, are obſerved to have other ſmaller ones conſtantly attending them, called *Secondary Planets*, or *Satellites.* Theſe Satellites always attend their reſpective Primaries in their Revolutions about the Sun, and at the ſame Time they are conſtantly moving about them. The Earth has one, *viz.* the

Moon, which attends it in it's annual Revolution about the Sun, and at the ſame Time moves round it as a Center, in about 27 Days, and 7 Hours. *Jupiter* has four Satellites attending him, which are at different Diſtances from him, and move round him in different Times, *viz.* that which is innermoſt, or neareſt his Body, revolves in 1 Day 18 Hours; the next deſcribes it's Orbit in 3 Days and 13 Hours; the third moves round in 7 Days and 3 Hours; and that which is furtheſt from *Jupiter*'s Body, performs it's Circuit in 16 Days and 18 Hours. *Saturn* has five Satellites moving round him as a Center, which are at different Diſtances from his Body, and perform their Revolutions in different Times, *viz.* the firſt or neareſt to him, performs it's Circuit in 1 Day, 21 Hours; the ſecond, in 2 Days, 17 Hours; the third, in 4 Days, 13 Hours; the fourth, in 15 Days, 22 Hours; and the fifth, or the moſt remote from the Body of *Saturn*, compleats it's Revolution in 79 Days and 8 Hours.

29. The *fixed Stars* are ſuppoſed to be of the ſame Matter with the Sun, and made for the ſame Ends, *viz.* each of them the Center of it's own proper Syſtem, having Planets moving round it as our Sun has.

30. Having given a curſory View of the Syſtem of the Univerſe, we ſhall now conſider the Motion of the Earth, a little more particularly. Let S repreſent the Sun in the Center, A B C D the Orbit of the Earth, and ♈ ♋ ♎ ♑ the Heaven of the fixed Stars; then if the Obſerver be ſuppoſed to be placed in the Sun at S, 'tis plain when the Earth is in the Point A of it's Orbit, it will appear to be at the fixed Star ♈, and while in moving from Weſt to Eaſt, it goes from the Point A of it's Orbit to B, it will appear to the Obſerver at S to paſs by

the fixed Stars ♈ ♉ ♊ ♋; and in moving from B to C, it will appear to paſs by the fixed Stars



♋ ♌ ♍ ♎; and from C to D, the fixed Stars ♎ ♏ ♐ ♑; and from D to A the fixed Stars ♑ ♒ ♓ ♈. Again, let the Obſerver be removed from the Sun to the Earth, then 'tis plain when the Earth is in the Point A of it's Orbit, the Sun S will appear to be in the oppoſite Point of the Heavens, *viz.* at the fixed Star ♎; and while the Earth is moving in it's Orbit from A to B, the Sun will appear to paſs by the fixed Stars ♎ ♏ ♐ ♑; alſo while the Earth moves from B to A, the Sun will appear to have moved from ♑ by the fixed Stars ♒ ♓, *&c.* ♍ ♎; conſequently the Sun to an Inhabitant of the

Earth will appear to paſs over the ſame fixed Stars, and towards the ſame Part of the Heavens, *i. e.* from Weſt to Eaſt, as the Earth appeared to an Obſerver in the Sun.

31. Hence ariſes the apparent Motion of the Sun from Weſt to Eaſt. So that if any fixed Star be obſerved to riſe with the Sun; ſome Days after, the Sun will have moved more eaſterly, and the Star will riſe before the Sun, and alſo ſet before it: Alſo if a Star, in or near the Path which the Sun appears to deſcribe in his annual Motion, and at ſome Diſtance from the Sun, be obſerved above the Horizon after Sun-ſet, it will ſome Time after that appear to ſet with the Sun, and for a while, will not be viſible at Night.

32. The ſame Way the Sun will appear to an Obſerver in any of the other Planets to move from Weſt to Eaſt, and to deſcribe the ſame Orbit in the Heavens that the Planet would appear to do to an Obſerver in the Sun.

33. The Circle in the Heavens that the Earth to an Obſerver in the Sun, or the Sun to an Obſerver in the Earth, appears to deſcribe is called the *Ecliptick*, and it is divided into twelve equal Parts called *Signs*, each containing 30 Degrees, *viz.* the $\frac{1}{12}$ of 360. The Names and Characters by which theſe Signs are uſually expreſſed, are as follow.

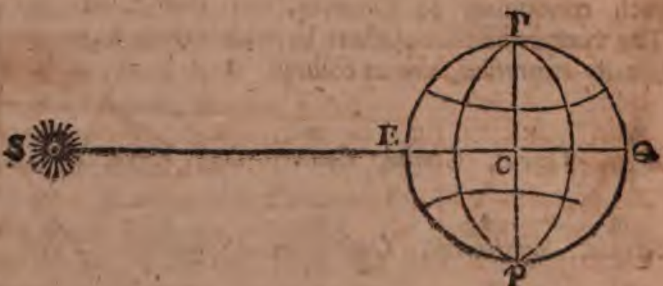
♈ ♉ ♊ ♋ ♌ ♍ ♎
Aries, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*,

♏ ♐ ♑ ♒ ♓
Scorpio, *Sagittarins*, *Capricornus*, *Aquarius*, *Piſces*.

34. Since the Earth is a ſpherical Body expoſed to the Rays of the Sun, 'tis plain Half of it's Body muſt be enlightened, while the other Half is in Darkneſs; and if there be a Line drawn from the

Center of the Sun to that of the Earth, and a Plane perpendicular to that Line paſſing thro' the Center of the Earth; then this Plane will cut the Earth in a great Circle, which will ſeparate the enlightened from the darkened Hemiſphere; and this Circle is called the *Terminator* of Light and Darkneſs upon the Earth.

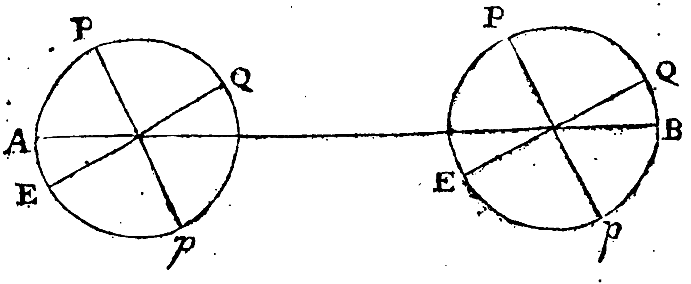
35. If the Plane of the Earth's Equator coincided with the Plane of the Ecliptick, and conſequently the Earth's Axis perpendicular to the Ecliptick, then the Terminator of Light and Darkneſs would be a Meridian; for let the Circle P E *p* Q repreſent the Earth, P and *p* it's two Poles, E Q the Equator, C the Center of the Earth, and S the Sun through which E Q if produced would paſs; then, by the laſt Article, the Terminator muſt be perpendicular to S E, and, conſequently, in this Caſe, to the Plane of the Equator E Q; but ſince all great Circles perpendicular to the Equator muſt paſs thro' the Poles, and ſo become Meridians; it follows that in this Caſe the Terminator muſt be alſo a Meridian, as P *p*. And ſince all Meridians biſect the Equator (by *Art.* 4. *Cor.* 2. of this) they muſt alſo biſect it's Parallels,



conſequently the Terminator which is here a Meridian, muſt biſect the Equator and it's Parallels;

therefore the Half of each Parallel muſt be always enlightened, and the other Half obſcured; and ſince by the Motion of the Earth about it's Axis, every Point upon it's Surface, except the Poles, deſcribes a Circle parallel to the Equator; it is evident, that if the Planes of the Equator and Eclipticк coincided, every Point upon the Earth's Surface, the Poles excepted, would have the Sun as long above it's Horizon as below it, and ſo there would be a conſtant Equality of Day and Night, *viz.* 12 Hours each. At the Poles the Sun would appear conſtantly moving round the Horizon.

36. The Axis of the Earth is obſerved to be inclined to the Plane of the Eclipticк in an Angle of about 66 $\frac{1}{2}$ Degrees, and conſequently the Plane of the Equator inclined to the Eclipticк, in an Angle of 23 $\frac{1}{2}$ Degrees, *viz.* the Complement of the former. Alſo the Axis of the Earth in it's annual Motion about the Sun, move always parallel to itſelf; ſo if a Line were drawn thro' the Center of the Sun, parallel to the Earth's Axis, while in any Point of it's Orbit, that Line would continue parallel to the Axis, whatever Point of the Orbit, the Earth is in (at leaſt



in a Year's Time the Difference is inſenſible.) And this muſt neceſſarily happen, if the Earth had no other Motion but a progreſſive one in it's Orbit, and a Rotation about it's Axis. For ſuppoſe any ſpherical Body as P E *p* Q, whoſe Center moves along the Line A B, and while in A, let any Diameter of it as P *p*, be aſſumed, inclined any Way to the Line A B; then 'tis plain if the Body had no other but the progreſſive Motion, when it has come to B, the Diameter P *p* will ſtill be parallel to it's former Situation while in the Point A; and if the ſame Body be ſuppoſed alſo to move round it's Axis P *p*, 'tis plain all Parts of it would conſequently be changing their Situations, except the Axis, which is no way affected by the Rotation, and conſequently the Axis muſt always keep parallel to the ſame right Line.

37. Since the Plane of the Equator is inclined to the Plane of the Ecliptick, therefore they muſt interſect one another in a right Line paſſing through the Center of the Earth, and the Plane of the Ecliptick muſt cut the Earth in a great Circle, which will be inclined to the Equator at an Angle of 23 $\frac{1}{2}$ Degrees, and this will mark out upon the Earth's Surface, the Path of the Sun in his annual Motion; the Line in which the Equator interſects the Ecliptick, muſt always be parallel to the ſame Line, whatever Point of the Orb the Earth be in; as is evident from the laſt *Article*.

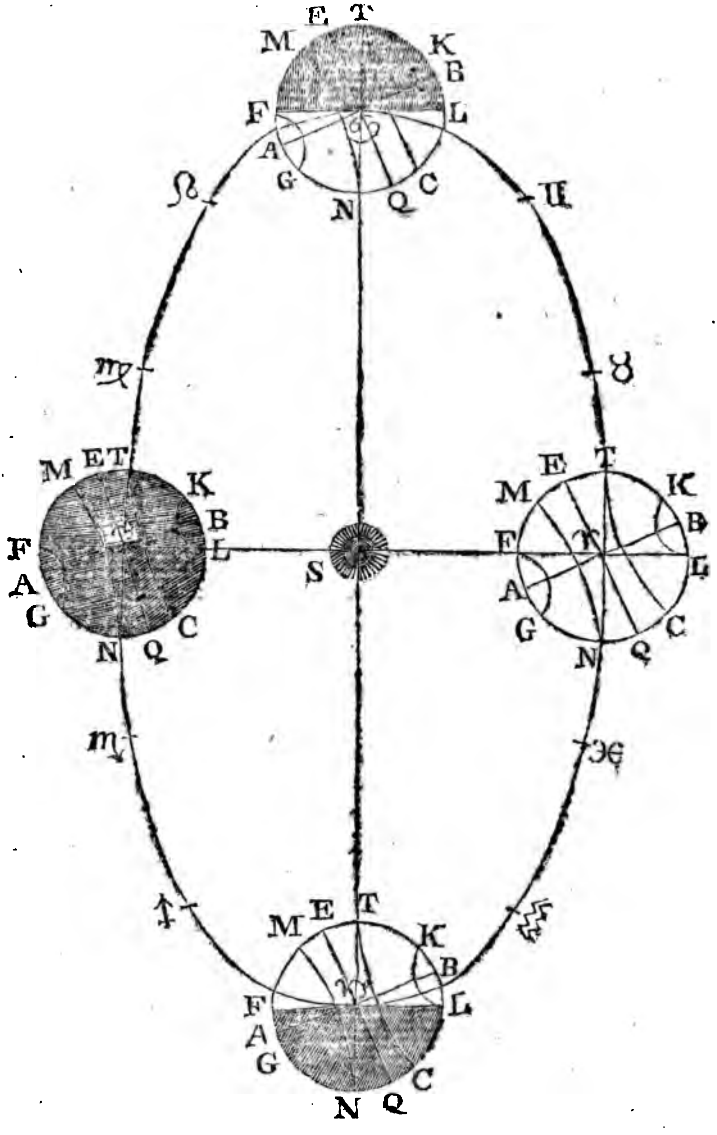
38. If thro' the Center of the Sun, there be drawn a Line perpendicular to the Plane of the Ecliptick; then this Line is called the Axis of the *Ecliptick*, and the two oppoſite Points in which the Axis meets the Heavens, are called the *Poles of the Ecliptick*.

39. That great Circle in the Heavens which paſſes thro' the Poles of the World, and the Points where the Ecliptick and Equator interſect, is called the *Equinoctial Colure*. And that great Circle which is at right Angles with the former, paſſing thro' the Poles of the Equinoctial and Ecliptick, is called the *Solſtitial Colure*. The fourth Points in which theſe Colures cut the Ecliptick, are called the *Cardinal Points*. Theſe two in which the equinoctial Colure meets the Ecliptick, are called *Equinoctial Points*; becauſe (as ſhall be ſhewn) when the Sun is in either of them there is an Equality of Day and Night to the Inhabitants of the Earth; and the two Points in which the ſolſtitial Colure cuts the Ecliptick, are called the *Solſtitial Points*; becauſe when the Sun comes to either of theſe Points, he is then at his greateſt Diſtance from the Equator, and is beginning to return to it again.

40. To explain the Phænomena or Appearances that ariſes from the Earth's annual Motion about the Sun; ſuppoſe ♑ ♈ ♋ ♎ the Earth's Orbit, and S the Sun; thro' S draw the right Line ♎ S ♈, parallel to the common Line of Interſection, of the Ecliptick and Equator, and meeting the Ecliptick in the two Points ♈ and ♎; alſo thro' S draw the Line ♑ S ♋ perpendicular to the former; then, 'tis plain when the Earth is in the Point ♎ of it's Orb, the Line S ♎, joining the Centers of the Sun and Earth, will coincide with the common Interſection of the Ecliptick and Equator, and conſequently be in the Plane of the Equator, therefore perpendicular to the Earth's Axis; this Line (by *Art.* 34.) is alſo perpendicular to the Terminator of Light and Darkneſs, whence it is evident the Axis of the Earth will lie in the Plane of the Terminator, which therefore muſt paſs thro' the Poles, and ſo become a Meridian; alſo the Sun will appear in the oppoſite Point of the Orb at ♈, *viz.* in the Line

♎ S produced, that is, in the Plane of the Equator; and conſequently by his apparent daily Motion, he will deſcribe the celeſtial Equator. And ſince in this Situation of the Earth, the Terminator of Light and Darkneſs is a Meridian, it will biſect the Equator and it's Parallels; conſequently Half of each Parallel will be in the enlightened Hemiſphere, and the other Half in the darkened; and every Point upon the Surface of the Earth, deſcribing by it's daily Motion, either the Equator or of it's Parallels; it plainly follows, that when the Earth is in the Point ♎ of it's Orb, each Place upon it's Surface, will remain as long in the enlightened Hemiſphere as in the darkened, *i. e.* there will be an Equality of Night and Day (*viz.* 12 Hours each) over all the Earth, except at the Poles, where the Sun will appear to deſcribe the Equator, which is the Horizon to either Pole.

The Earth, by it's annual Motion being carried along the Signs ♏ ♐, the Line of Interſection of the Ecliptic and Equator remaining always parallel to itſelf, it cannot now be directed towards the Sun; but when the Earth is in the firſt Point of ♑, it muſt make with the Line S ♑, joining the Centers of the Earth and Sun, a right Angle. And ſince the Line S ♑ is not in the Plane of the Equator, but of the Ecliptick, the acute Angle B ♑ S, that the Axis of the Earth A B makes with S ♑, will be equal to 66 $\frac{1}{2}$ Degrees, *viz.* the Inclination of the Axis of the Earth to the Ecliptick. Thro' the Center of the Earth ♑, draw the Circle F L, perpendicular to S ♑, and this will be the Terminator of Light and Darkneſs, (by *Art.* 34.) and the Arch B L will be 23 $\frac{1}{2}$ Degrees, *viz.* the Complement of T B. From the Center ♑, deſcribe the Circle Q E perpendicular to the Axis A B, and this will be the Equator; then ſince the Arch E B is equal to the Arch T L, (being each a Quadrant) by taking away the common Arch T B, we have E T



equal to B L, *i. e.* 23 ½ Degrees. Make the Arch EM

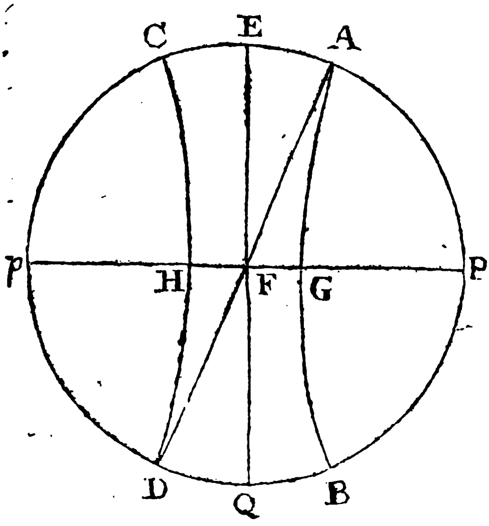
E M equal to E T, and thro' the Points T and M draw the Circles T C, M N parallel to the Equator; then 'tis plain that when the Earth is in the Point ♑ of it's Orbit, the Sun will be perpendicular to the Point T, diſtant from the Equator E Q, towards the North Pole B, $23\frac{1}{2}$ Degrees, which is his greateſt Declination North. The Parallel T C is called the *Tropick* of *Cancer*, and the Circle in the Heaven concentrick with this, which the Sun appears to deſcribe at that Time, is called the *Celeſtial Tropick* of *Cancer*; becauſe the Sun at that Time appears to be in the Sign ♋. And becauſe of the Earth's Rotation about it's Axis, 'tis plain that all the Points ſituate upon the Parallel T C, will have the Sun, when upon their Meridian, in their Zenith. Alſo when the Earth is in this Poſition, 'tis plain that the Terminator of Light and Darkneſs F L, will go beyond the North Pole B to L, $23\frac{1}{2}$ Degrees diſtant from B; and conſequently the South Pole A muſt be as far from the Terminator L F in the darkened Hemiſphere. Thro' the Points L and F, draw the Circles L K, F G, parallel to the Equator, and theſe are called *Polar Circles*, that towards the North being the *Arctick Circle*, and that towards the South the *Antarctick Circle*. Now ſince the Earth moves round upon it's Axis A B, 'tis evident that every Point within the arctick polar Circle K L, will, at that Time, have a continued Day; and, on the contrary, every Point within the antarctick polar Circle F G, will have a continued Night.

Again, the Earth moving forwards thro' the Signs ♒ ♓ to ♈, the Sun will appear to move thro' the Signs ♋, ♌, ♍, and by Degrees to return again to the Equator; and when the Earth is arrived at the Point ♈ of it's Orbit, the Sun will appear to be at ♎. Now the common Interſection of the Ecliptick and Equator ſtill remaining parallel to the Line ♎ S ♈, it follows that when the Earth is come to ♈, the Line S ♈, joining the Centers of the Earth and Sun, will lie in the Plane of the Equator; and conſequently the Sun will appear in the celeſtial Equator, and there will be an Equality of Night and Day, the ſame Manner as when the Earth was in ♎. In this Situation, the Terminator of Light and Darkneſs will again paſs thro' the two Poles.

The Earth moving forwards through the Signs ♈ ♉ ♊, the Sun will appear to move thro' the oppoſite Signs ♎ ♏ ♐, gradually declining from the Equator, towards the South Pole, and when the Earth comes to ♋, the Sun appears to be in ♑. Now ſince the Axis of the Earth AB does not change it's Inclination to the Ecliptick, the Earth will have the like Aſpect and Poſition with reſpect to the Sun, as it had when in the Point ♑ of it's Orbit; but with this Difference, that he is now as far on the South Side of the Equator, as (when the Earth was in ♑) he was on the North Side, *i. e.* 23 ½ Degrees, and is perpendicular to the Point N; the Parallel NM is called the *Tropick* of *Capricorn*, and the Circle in the Heavens concentrick to this which he appears to deſcribe at this Time, is called the *Celeſtial Tropick* of *Capricorn*; becauſe at this Time the Sun appears to be in the Sign ♑; alſo, all within the North polar Circle KL, which was enlightened when the Earth was at ♑, is now in Darkneſs, and all within the South polar Circle, is now enlightened.

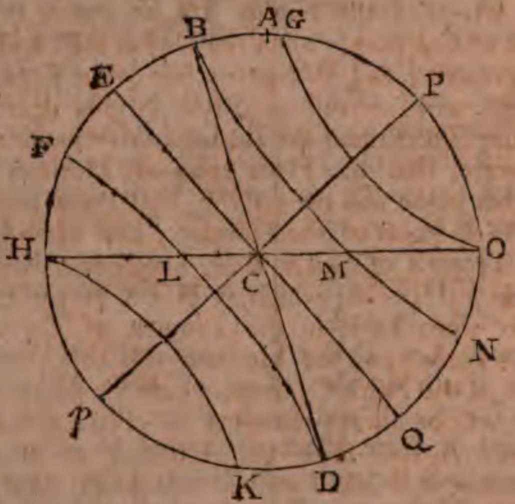
41. We ſhall now conſider more particularly the Appearances which happen in the different Places upon the Earth, ariſing from it's annual Motion about the Sun, in Conjunction with the Rotation about it's Axis. In order to which we muſt conſider, that the Inhabitants of the Earth, with reſpect to their Situation upon it, are divided into three Kinds, *viz.* *Firſt*, Such as live upon the Equator. *Secondly*, Such as live between the Poles and Equator.

Thirdly, Such as live upon either Pole. As for thoſe that live upon the Equator; let E*p*QP be the Projection of the Earth upon the Plane of ſome Meridian, P the North, and *p* the South Pole, EQ the Equator, and E ſome Place upon it; alſo D A the Ecliptick, C D the Tropick of *Capricorn*, and A B the Tropick of *Cancer*. Then 'tis plain that an Inhabitant upon ſome Point of the Equator, ſuppoſe E, will have the Poles P and *p* in his Horizon, which therefore muſt be a Meridian. Now as all Meridians biſect the Equator and it's Parallels at right Angles, and all the Heavenly Bodies deſcribing Parallels in their apparent diurnal Motion; it follows that in one entire Revolution of the Earth about it's Axis, all the Heavenly Bodies muſt come in View, and they muſt riſe and ſet perpendicular to the Horizon, and remain juſt as long above it, as below, *i. e.* twelve Hours each. Now the Sun always deſcribing ſome Parallel, or the Equator itſelf, in his diurnal Motion; it will follow, that to an Inhabitant



upon the Equator there muſt be a conſtant Equality of Night and Day, *viz.* twelve Hours each; and when the Sun in his annual Motion comes to be perpendicular to the Point F, he will then deſcribe the Equator in his diurnal Motion; and conſequently when he comes upon the Meridian of any Place, E, on the Equator, he will be in the Zenith of it; and moving on in the Ecliptick till he be perpendicular to the Point A, (when he is at his greateſt Declination from the Equator towards the North Pole P, *viz.* 23 $\frac{1}{2}$ Degrees) he will then deſcribe the Tropick of *Cancer* A B, and when he comes on the Meridian of E, he will be removed from the Zenith towards the North 23 $\frac{1}{2}$ Degrees; and moving ſtill on in the Ecliptick, he will appear to return towards the South, and paſſing the Zenith of E, he will go as far South, as he was before North, *viz.* 23 $\frac{1}{2}$ Degrees. Conſequently an Inhabitant on the Equator will have the Sun in his Zenith twice in one Year, and alſo the Sun will be half the Year on the North Side, and half the Year on the South Side of him; and therefore will be conſtantly changing his Place in the Horizon, for when he is deſcribing the Parallel A B, he will appear in the Horizon at G, and when he is deſcribing the Equator E Q, he will be in the Horizon at F (the Eaſt or Weſt Points;) alſo when he is deſcribing the Parallel C D he will appear in the Horizon at H South of the Point F.

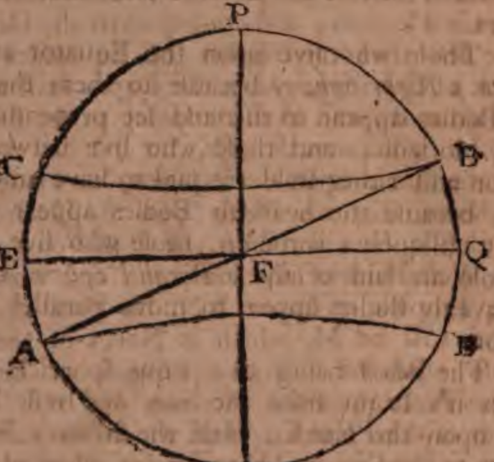
Again, Let P E *p* Q repreſent the Projection of the Earth on the Plane of ſome Meridian, P and *p* the North and South Poles, E Q the Equator, and A ſome Place upon that Meridian, lying between the Equator and North Pole, whoſe Horizon is H O; alſo B D the Ecliptick, B N the Tropick of *Cancer*, and F D the Tropick of *Capricorn*; thro' the Points H and O, draw the Parallels O G, H K. Then 'tis plain, that to an Inhabitant at A, the North Pole P will be elevated, and the South Pole *p* depreſſed, the former as much above as the latter below the Horizon, which will cut the Equator and it's Parallels obliquely. Now ſince the Horizon and Equator are great Circles, they muſt biſect one another (by *Art.* 4. *Cor.* 2.) therefore Half the Equator will be above, and Half below the Horizon; conſequently when the Sun is perpendicular to the Point C, that is, when he appears to be in the Equator, there will be an Equality of Night and Day. And ſince the Horizon cuts the Parallels obliquely, it muſt therefore cut them unequally; and 'tis plain from the Scheme, that of all thoſe Parallels which lie between the Equator and neareſt Pole, the greater Part is above, and the leſs below the Horizon; and thoſe that lie on the other Side of the Equator, have the leſſer



Part above, and the greater below the Horizon; and the nearer the Parallels are to the Poles, the more unequally are they cut by the Horizon;

conſequently while the Sun is upon the North Side of the Equator, and by his diurnal Motion deſcribing Parallels, lying between the Equator and North Pole, he will be longer above than below the Horizon of the Place A; and when he comes to his greateſt Declination North, and then deſcribes the Tropick of *Cancer*, the Days muſt then be at the longeſt to the Place A; alſo the Sun returning towards the Equator, he will deſcribe Parallels, whoſe Parts above the Horizon, approach ſtill nearer to an Equality with thoſe below, and ſo the Days will ſtill decreaſe and come nearer to an Equality with the Nights, 'till he comes to the Equator, when the Day and Night are equal; and proceeding from the Equator towards the South Pole, he will then deſcribe Parallels lying between the Equator and South Pole, whoſe leaſt Part is above, and greateſt Part below, the Horizon; and conſequently the Days will ſtill be leſs than the Nights 'till he comes to the Tropick of *Capricorn*, when the Day is leaſt and the Night greateſt; and then returning to the Equator, the Days will increaſe and the Nights decreaſe. When the Sun is upon the Equator, 'tis evident, by the Scheme, that his Place upon the Horizon will be C, that is, he will riſe on the Eaſt Point and ſet on the Weſt Point of the Horizon; and when he is in the Tropick of *Cancer* B N, his Place upon the Horizon will be M, which is North of the Point C; alſo when he is in the Tropick of *Capricorn* F D, his Place upon the Horizon will be L, which is South of the Point C; from which 'tis plain, that the Sun will be always changing his Place upon the Horizon. Again, ſince the Horizon of A cuts the Equator and it's Parallels obliquely, and the Heavenly Bodies by their apparent diurnal Motion, deſcribe Parallels, 'tis plain they muſt riſe and ſet obliquely; but all thoſe within the Parallel G O do not riſe and ſet, and therefore muſt conſtantly be in View; for which Reaſon this Parallel G O is called *The Circle of Perpetual Apparition*; and all within the Parallel H K do never come in View, but are conſtantly below the Horizon, and therefore the Parallel H K is called *The Circle of Perpetual Occultation.*

Laſtly, Let P E *p* Q repreſent the Projection of the Earth upon ſome Meridian, P the North and *p* the South Pole, E Q the Equator, A B the Ecliptick, B C the Tropick of *Cancer*, and A D the Tropick of *Capricorn*; then 'tis plain that the Equator is the Horizon of both Poles, and conſequently the Northern Hemiſphere muſt always be in View, and the Southern always hid to an Inhabitant at P; likewiſe the Heavenly Bodies will appear to move in Circles parallel to the Horizon, and the fixed Stars will ever deſcribe the ſame Parallels, and always have the ſame Height above the Horizon. When the Sun by his annual Motion

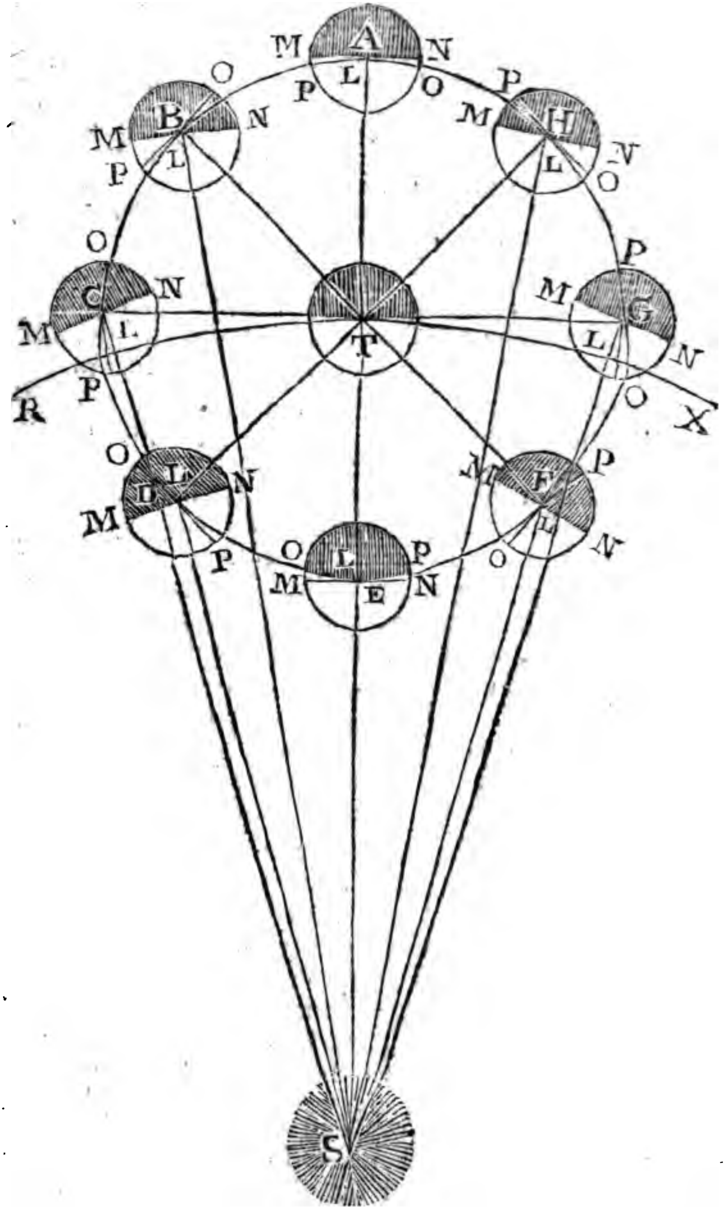


comes to be perpendicular to the Point F, and then deſcribes the Equator, it is plain he will be in the Horizon of both Poles, and by his diurnal Motion will appear to move quite round it; and ſince Half the Ecliptic F B is above, and the other Half F A below the Horizon of P, therefore, during the Time the Sun is deſcribing that Half of the Ecliptic on the North Side of the Equator, he will be above the Horizon of P, and all the Time he is in deſcribing the other Half on the South Side of the Equator, he will be below the Horizon of P; from whence it follows, that an Inhabitant at either Pole will have Half a Year continued Day, and as long Night. And ſince the Sun's greateſt Diſtance from the Equator South or North is 23½ Degrees, his greateſt Altitude above, or Depreſſion below the Horizon of either Pole, muſt be 23½ Degrees.

42. Thoſe who live upon the Equator are ſaid to have a *Right Sphere*, becauſe to them the Heavenly Bodies appear to riſe and ſet perpendicularly to the Horizon; and thoſe who live between the Equator and either Pole are ſaid to have an *Oblique Sphere*, becauſe the heavenly Bodies appear to riſe and ſet obliquely; and *laſtly*, thoſe who live on either Pole are ſaid to have a *Parallel Sphere*, becauſe the heavenly Bodies appear to move parallel to the Horizon.

43. The *Moon* being an opaque ſpherical Body, receives it's Light from the Sun, and reflects that Light upon the Earth; Half the Moon's Body is oppoſite to the Sun, and therefore enlightened, while the other Half which is turned from it, is involved in Darkneſs; but the Half which is viſible to us, is that which is oppoſite to the Earth, and will, according to the various Situations of the Moon with reſpect to the Earth and the Sun, have different Illumina-

tions; for ſometimes a greater and ſometimes a leſs Part of the enlightened Hemiſphere is obverted to the Earth; and ſometimes the Whole, and ſometimes no Part of the enlightened Hemiſphere, is ſeen from the Earth. To explain this, let S repreſent the Sun, T the Earth, R T X a Part of the Earth's Orbit, which it deſcribes in it's annual Motion about the Sun, A B C D E F G H the Orbit of the Moon, in which it moves round the Earth from Weſt to Eaſt, in the Space of a Month; P N O M the Moon's Body, and L it's Center; join the Centers of the Sun and Moon with the right Line S L, then ſuppoſe the Plane M L N to paſs through the Center of the Moon, perpendicular to the Line S L; and this Plane will cut the Surface of the Moon in a great Circle, which will be the Terminator of Light and Darkneſs, *viz.* it will divide the enlightened Hemiſphere from the darkened: Alſo let the Centers of the Earth and Moon be joined with the right Line T L, and perpendicular to it draw a Plane, paſſing through the Center of the Moon, and this will cut the Moon's Surface in a Circle P L O, which will divide the viſible from the inviſible Hemiſphere of the Moon; this Circle is called *The Circle of Viſion.* And hence it is plain, that if the Moon be in the Point A of it's Orbit oppoſite to the Sun, the Circle of Viſion P L O will coincide with the Terminator M L N, and ſo the whole enlightened Hemiſphere of the Moon will be turned towards the Earth, and then it is called *Full Moon*, and with reſpect to the Situation of the Sun, it is ſaid to be in *Oppoſition*; becauſe the Sun and Moon, ſeen from the Earth, appear at that Time to be in oppoſite Points of the Heavens. When the Moon is come to the Point B of it's Orbit, the whole enlightened Hemiſphere will not be turned to the Earth, but a Part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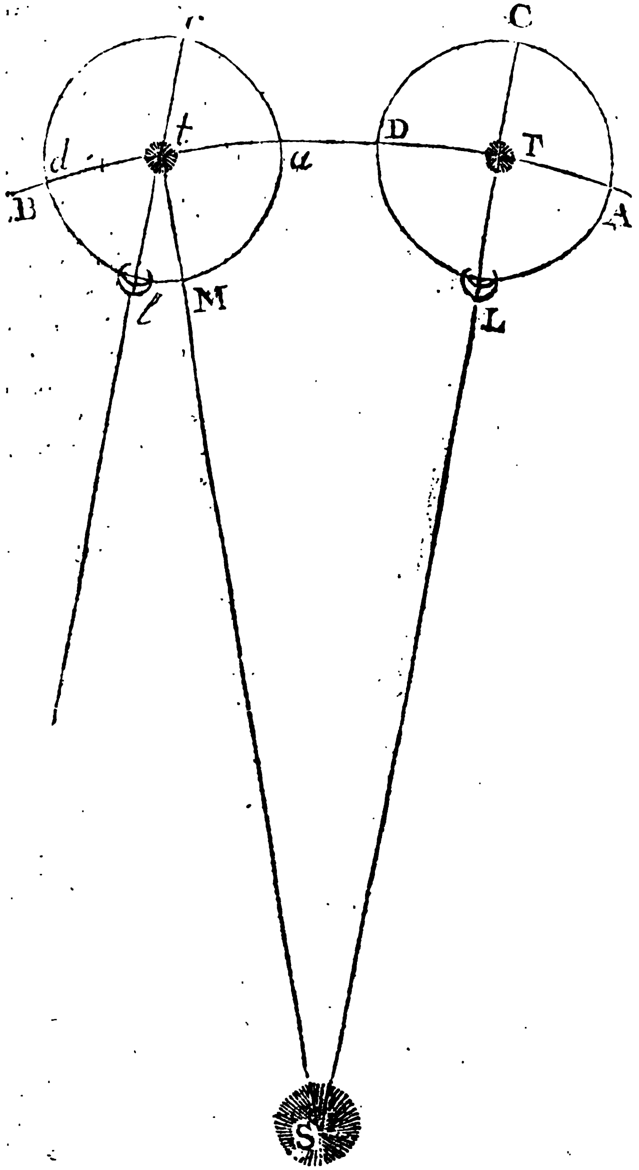
of it, as M P will be without the viſible Hemiſphere, and therefore the viſible illuminated Part cannot be circular, but will appear gibbous; when the Moon is in the Point C of her Orbit, and the Angle C T S a right one, the Angle T C S will alſo be nearly a right Angle: Becauſe of the great Diſtance of the Sun from the Earth and Moon, the Lines S T, S C, are nearly parallel; conſequently the Circle of Viſion will biſect the Terminator at right Angles, and ſo only one Half of the enlightened Hemiſphere will be viſible, and then the Moon appears to be halved, and is called *Half Moon.* In this Situation the Moon is only a Quadrant's Diſtance from the Sun, and therefore it is ſaid to be in it's *Quadrature.* The Moon proceeding to D, it is plain that in this Situation only a ſmall Part P N of the enlightened Hemiſphere is turned towards the Earth, and the greateſt Part N O of the enlightened Hemiſphere is now inviſible; and conſequently, becauſe of the ſpherical Figure of the Moon, it will appear horned, and it's Horns will be turned towards the Weſt. When the Moon is arrived at E, the Circle of Viſion will again coincide with the Terminator, and the whole enlightened Hemiſphere will be turned from the Earth, and then it is ſaid to be *New Moon*; but with reſpect to it's Situation from the Sun it is ſaid to be in *Conjunction*, becauſe it appears to be in the ſame Point of the Ecliptic with the Sun; and when it has moved a little forward to F, Part of the enlightened Hemiſphere, *viz.* M O, will be ſeen from the Earth, and the Moon will again appear horned, having thoſe Horns turned towards the Eaſt; alſo when at G it will appear halved, and when at H gibbous; and *laſtly*, when it comes to A it will appear full.

44. Though (as was ſaid in *Art.* 28.) the Moon moves quite round it's Orbit in 27 Days and 7 Hours nearly, called the *Periodic Month*; yet the Time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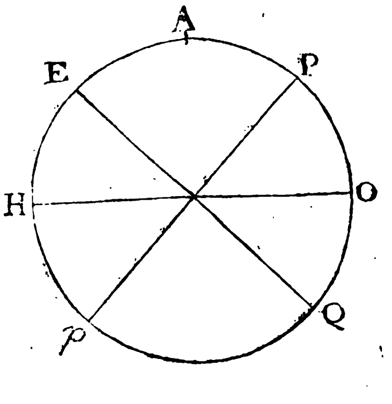
Time it takes from one Conjunction with the Sun to the next, is greater; being 29 Days, and about 12 Hours, which is called *The Synodic Month*; for let S be the Sun, T the Earth, A B a Part of the Earth's Orbit about the Sun, and A L D C the Orbit of the Moon; then when the Earth is in T, let the Moon be in L, in Conjunction with the Sun, and while the Moon is moving from L round it's Orbit L A C D, the Earth in the mean Time will be moving on in it's Orbit about the Sun, and carrying the Moon's Orbit along with it: And when the Moon has moved quite round it's Orbit, the Earth will be carried from T to *t*, and the Moon's Orbit will be in the Situation *l a c d*, and the Point L will be in the Line *t l*, parallel to the former T L, conſequently the Moon will then be in *l*; but will not be in Conjunction with the Sun till it has moved a little further, and deſcribed the Arch *l* M, which is ſimilar to the Arch *t* T, becauſe the Angles *l t* M, *t* S T, are equal (by *Art.* 36. *Sect.* I.) And hence it is, that notwithſtanding the Moon moves round it's Orbit in 27 Days 7 Hours, yet from new Moon to new Moon is always 29 Days 12 Hours, very near.

45. If the Moon's Orbit coincided with the Plane of the Ecliptic, it is evident the Moon would in one Month move round the ſame Circle in the Heavens that the Sun appears to deſcribe in a Year, *viz.* the Ecliptic; but the Moon's Orbit does not lie in the ſame Plane with the Ecliptic, but is inclined to it at an Angle of about five Degrees, and conſequently muſt interſect it in a right Line paſſing through the Center of the Earth; therefore Half the Moon's Orbit will be above the Ecliptic towards the North, and the other Half below towards the South. The Line of Interſection is called *The Line of the Nodes*, the Extremities of which are called *The Nodes*. The Node in which the Moon is when

aſcending above the Ecliptic towards the North, is called *The Aſcending Node*, or *Dragon's Head*, for Brevity's ſake marked thus ☊; the oppoſite one, *viz.* that in which the Moon is when deſcending below the Ecliptic towards the South, is called *The Deſcending Node*, or *Dragon's Tail*, marked thus ☋. Hence it is plain, that the Moon cannot appear in the Ecliptic above twice in one Period, *viz.* when in the Nodes; and in other Points of it's Orbit it will be more or leſs diſtant from the Ecliptic, according as it is more or leſs removed from the neareſt Node; the two oppoſite Points in the Orbit, which lie in the Middle between the Nodes, are called *The Limits*; and when the Moon is in either of theſe, ſhe is then at her greateſt Diſtance from the Ecliptic.

46. The Elevation of the neareſt Pole above the Horizon of any Place, is equal to the Latitude of that Place. For let A be a Place upon the Earth, A H O it's Meridian, and H O it's Horizon, E Q the Equator, P and *p* the Poles; then is A E the Latitude of the Place, and P O the Height of the



neareſt Pole above the Horizon. Now ſince the Arches P E and A O are equal, being each a Quadrant, from both take the common Arch A P, and there will remain A E equal to P O; that is, the Height of the Pole above the Horizon is equal to the Latitude. Alſo ſince the Arches A H and E P are equal, being both Quadrants, from both take the common Arch A E, and there will remain E H equal A P; that is, the Height of the Equator above the Horizon of any Place, is equal to the Complement of the Latitude of that Place.

47. Great Circles paſſing through the Poles of the Ecliptic, and cutting it at right Angles, are called Secondaries of the Ecliptic.

48. *The Latitude* of any heavenly Body, is an Arch of the Secondary paſſing through the Center of the Object, intercepted between it and the Ecliptic; and it is either North or South, according as the Object is on the North or South Side of the Ecliptic.

49. *The Longitude* of any celeſtial Body, is an Arch of the Ecliptic intercepted between the Secondary paſſing through that Body, and the firſt Point of *Aries.*

50. *The Declination* of any heavenly Body, is an Arch of a Meridian paſſing over that Body, intercepted between the Center of it and the celeſtial Equator; and it is either North or South, according as the Body is on the North or South Side of the Equator.

51. Since the Sun by his annual Motion is always either approaching nearer to, or going further from the Equator, it is plain he muſt be continually changing his Declination. In the third Table at the End of this Book, you have his Declination for every Day of the Year, in which you may obſerve, that in the Top Columns ſtand the Year, Month, and Kind of the Declination, *viz.* whether it be South or North; and in the Left-hand

Column ſtands the Day of the Month; the other Columns contain the Declinations anſwerable to theſe: Conſequently, to find the Sun's Declination for any Day, ſuppoſe the twentieth of *April*, 1772, I look at the Top for the Year 1772, and the Month *April*, and in the Side Column for 20, then in the Column below *April*, and on the ſame Line with 20 I find 11°, 29′, for his Declination North; and the ſame Way his Declination may be found for any other Day. But you muſt obſerve, that this Table is calculated only for the Meridian of *London*, that is, it ſhews the Declination of the Sun when upon the Meridian of *London*; and conſequently, to find the Sun's Declination for any other Time of the Day, we muſt conſider whether the given Time be before or after Noon; if it be before, then ſay, As 24 Hours is to the Difference between the Declination of the Sun, the Noon of the preceding Day, and his Declination the Noon of the preſent Day; ſo is the Time from Noon laſt Day, to a fourth Proportional; which, if the Declination be increaſing, muſt be added to, but if decreaſing, ſubtracted from the Sun's Declination the Noon of the preceding Day; and the Sum, or Remainder, is the Declination for the preſent Time.

Example. Suppoſe it were required to find the Sun's Declination on the fifteenth Day of *April*, 1776, at 8 Hours 25 Minutes in the Morning: To do this, I firſt look in the Tables, for the Sun's Declination the fifteenth Day of *April*, 1776, and find it to be 10° N; then I look for it the fourteenth Day, and find it to be 9°, 39′, N; the Difference of theſe is 21′; then I ſay, As 24 Hours is to 21′; ſo is 20 Hours 25 Minutes, the Time elapſed ſince laſt Noon, to 18′; which added to 9°, 39′ (becauſe the Declination is increaſing) gives 9°, 51′, for the Sun's preſent Declination. Again, if the Time propoſed be after Noon; then to find the Declination for that Time, we muſt look in the Tables, for the Sun's Declination the Noon of the preſent Day; and for the ſame the Noon of the following Day, and take the Difference of theſe Declinations; then ſay, As 24 Hours is to the Difference of the Declinations; ſo is the Time elapſed ſince Noon, to a fourth Proportional; which added to, or ſubtracted from, the Sun's Declination the preſent Day at Noon (according as the Declination is increaſing or decreaſing) gives the Sun's Declination at the Time propoſed.

Example. Suppoſe it were required to find the Sun's Declination on the twenty-third Day of *July*, 1777, at 4 Hours 23 Minutes after Noon. To do this we muſt firſt look in the Tables, for the Sun's Declination the twenty-third Day of *July*, 1777, and will find it to be 20° N; then for his Declination the following Day, which is 19°, 50′, N; and the Difference between theſe two is 10′; then ſay, As 24 Hours is to 10′; ſo is 4 Hours 23 Minutes, the Time elapſed ſince Noon, to 2′ nearly, which (becauſe the Sun's Declination is decreaſing) ſubtracted from 20°, the Declination of the Sun at Noon of the preſent Day, leaves 19°, 58′, the Sun's Declination for the Time propoſed.

And ſince the Table of the Sun's Declination at the End of this Book, is fitted to the Meridian of *London*, it cannot ſerve for the Meridian of any other Place, either on the Eaſt or Weſt Side of the Meridian of *London*; for while the Sun by his apparent diurnal Motion is paſſing from one Meridian to another, he is at the ſame Time ſtill moving on in the Ecliptic, and conſequently altering his Declination. Now to find the Declination of the Sun when he is on the Meridian of any Place, lying on the Eaſt or Weſt Side of *London*, we muſt take the Difference of Longitude between *London* and the given Place (or if the Meridian of *London* be ſuppoſed the firſt Meridian, we muſt take the Longitude of the Place) and convert this into Difference of Time, which will ſhow the Time before or after Noon at *London*, the Sun is upon the Meridian of the Place propoſed, *viz.* if the Place lie on the Eaſt Side of *London*, the Time will be before Noon; but if on the Weſt, it will be after Noon; then finding, according to the preceding Examples, the Sun's Declination at the Time propoſed, the ſame will be his Declination when on the Meridian of the given Place.

This may be done another Way, *viz.* by the Help of the Table of the Variation of the Sun's Declination to every 15 Degrees of Longitude from the Meridian of *London*, annexed to the Table of Declination; the upper Column of which contains the Degrees, and the Left-hand Side Column contains the Minutes of the Sun's daily Variation; and the other Columns contain the Minutes anſwering to the Degrees and Minutes in the Top and Side Columns. Now to find the Sun's Declination any Day, when he is on the Meridian of any Place lying on the Eaſt or Weſt Side of *London*, by this Table; we muſt firſt find the Sun's Declination for the preſent and for the following Day, and the Difference between theſe two will give us the daily Variation at that Time; then look in the Table of Variation, &c. at the Top, for the Difference of Longitude between *London* and the propoſed Place, and in the Side Column for the Minutes of Variation; then below theſe Degrees, in the Top and on the ſame Line with the Variation in the Side Column, we ſhall find the Variation required; which, if the propoſed Place be Weſt of *London*, and the Declination increaſing, muſt be added to the Declination for the preſent Day, and the Sum is the Declination required; but if the Declination be decreaſing, then the Variation ſubtracted from the Declination, gives that required. Again, if the Place lie on the Eaſt Side of *London*, and the Declination increaſing, then the Variation ſubtracted from the Declination for that Day, leaves the Declination required; but if the Declination be decreaſing, then the Variation added to the Declination, gives that required.

Example. Let it be required to find the Sun's Declination when he is on the Meridian of St. *Lucia* (whoſe Longitude from *London* is 60°, 15′, Weſt) on the ſeventeenth Day of *May*, 1777. To do this, I firſt look in the Tables for the Declination of the Sun the ſeventeenth Day of *May*, 1777, and find it to be 19°, 25′, N. and for the following Day, and I find it to be 19°, 39′, N. the Difference of which is 14 Minutes, the Sun's daily Variation at that Time; then I look in the Top of the Table of Variation, *&c.* for 60, the Difference of Longitude, and in the Side Column for 14; and below 60, and in the ſame Line with 14, I find 2 Minutes, which (becauſe the Place is Weſt of *London*, and the Declination increaſing) I add to 19°, 25′, and the Sum is 19°, 39′, the Sun's Declination at St. *Lucia* the ſeventeenth Day of *May*, 1777.

From hence you may obſerve, that the Method of ſolving this Problem by the Table of Variation, *&c.* is not ſo exact as the former; for here we can only enter the Table with a Number of Degrees, which is either 15°, or ſome Multiple of it below 195°, and all the odd Degrees and Minutes muſt be thrown away; but in the former Method we can uſe any Number of Degrees and Minutes.

52. Since the fixed Stars always keep the ſame Places in the Heavens (at leaſt in a few Years their Variation is inſenſible) it is plain their Declination muſt ſtill be the ſame. At the End

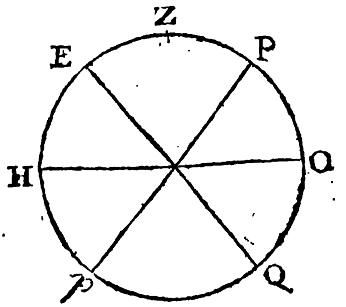
of the Tables of the Sun's Declination and Variation, there is a Table of the Declinations of the moſt principal fixed Stars.

SECT. IV.

TO find the Latitude of a Place by the Meridian Altitude and Declination of any celeſtial Body.

This *Problem* admits of ſeveral *Caſes*, according as the obſerved Object is ſituate with reſpect to the Equator, and Place of Obſervation, which are as follow:

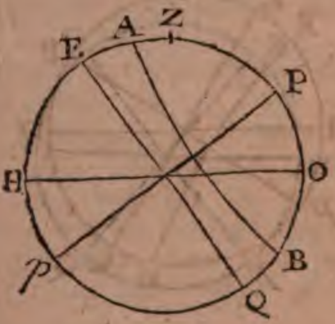
Caſe 1. When the Sun or Star obſerved has no Declination, it is upon the Equator, and then the Zenith Diſtance of the Object is equal to the Latitude of the Place, which is North Latitude if the Sun or Star comes to the Meridian on the South



Side of the Zenith; but South, if on the North Side. For in the annexed Scheme, let Z repreſent the Place of Obſervation, P Q *p* E it's Meridian, E Q the Equator, H O the Horizon, P the North, and *p* the South Pole; then ſince the obſerved Object is ſuppoſed to have no Declination, E Q will repreſent the Path of it's diurnal Motion, and when it comes upon the Meridian, Z E will be it's Zenith Diſtance, which is manifeſtly equal to the Latitude of the Place Z. And when the Object at E is South of Z, it is plain the Place Z muſt be North of E, and conſequently the Latitude will be North.

Caſe 2. If the Sun or Star, when on the Meridian, is in the Zenith, then the Declination of the Object is the ſame with the Latitude of the Place. For it is evident that in this Caſe they are equally diſtant from the Equator, and on the ſame Side of it; conſequently if the Declination be North, the Latitude will alſo be North; and if South, the Latitude will be South.

Caſe 3. If the Sun or Star be between the Equator and Place of Obſervation, then the Latitude of the Place is equal to the Sum of the Zenith Diſtance and Declination of the Object; and it is of the ſame Name with the Declination; that is, if the Declination be North, the Latitude is alſo North, *&* *è contra.* For in the adjacent Scheme, let A B repreſent the Parallel deſcribed by the

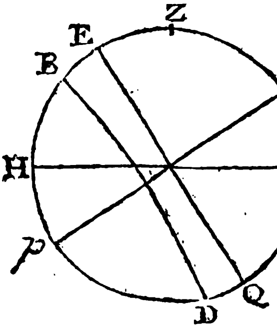


obſerved Object in it's diurnal Motion, and A it's Place upon the Meridian, between Z, the Place of Obſervation, and E Q the Equator; then will Z E, the Latitude of the Place Z, be equal to the Sum of E A, the Declination, and A Z the Zenith Diſtance; and if the Declination be North, the Latitude will alſo be North, *& è contra*; ſince in this Caſe the Object and Place of Obſervation lie both on the ſame Side of the Equator.

Example. Suppoſe on the twenty-third Day of *April*, 1776, the Sun, when on the Meridian, has 52°, 12', of Altitude, and conſequently 37°, 48', Zenith Diſtance, required the Latitude of the Place of Obſervation.

The Sun's Declination for that Day is	12°, 45', N.
His Zenith Diſtance - - - - - -	37°, 48',
The Sum is the Latitude, *viz.* -	50°, 33', N.

Caſe 4. If the Sun or Star be on the contrary Side of the Equator, with the Place of Obſervation, and conſequently both Declination and Zenith Diſtance of the ſame Name, *viz.* either both North or both South; then the Latitude is found by



by taking the Declination from the Zenith Diſtance; and it is of a contrary Name with the Declination. For in the adjacent Figure, let B D repreſent the Parallel deſcribed by the obſerved Object in it's diurnal Motion, on the other Side of the Equator E Q, with the Place Z, and B will be it's Place when upon the Meridian; then if from Z B, the Zenith Diſtance, be taken B E, the Declination, there will remain Z E, the Latitude of the Place of Obſervation Z, and the Latitude will be of a contrary Name with the Declination; ſince in this Caſe, the Object and Place are on contrary Sides of the Equator.

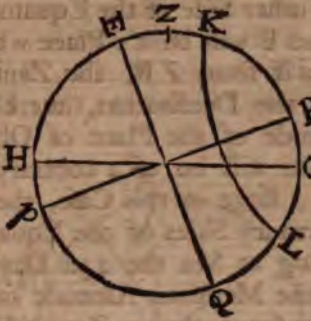
Example. Being at Sea the 23d Day of *January*, 1776, I found the Meridian Altitude of the Sun to be 43°, 15′; conſequently his Zenith Diſtance 46°, 45′, and he was South of me: Required the Latitude of the Place of Obſervation, and which Way it is.

From the meridional Zenith Diſtance 46°, 45′, S.
take the Sun's Declination - - - 19°, 21′, S.

there remains the Latit. of the Place - 27°, 24′, N.

When the Zenith Diſtance and Declination are equal, and both of the ſame Name, then the Latitude vaniſhes, and conſequently the Place is ſituated on the Equator.

Caſe 5. If the Sun or Star be between the Place of Obſervation and the neareſt Pole, and conſequently both Declination and Zenith Diſtance be of the ſame Name; then from the Declination ſubtract the Zenith Diſtance, and the Remainder is the Latitude of the Place of Obſervation, and it is of the ſame Name with the Declination. For in the annexed Scheme, let K L repreſent the Parallel deſcribed by the obſerved Object in it's diurnal Motion, and K will be it's Place when upon the Meridian; then it is plain, that if from K E, the Declination, be taken Z K, the meridional Zenith Diſtance, there will remain ZE the Latitude of the Place, which will be of the ſame Name with the Declination, ſince the Object and Place of Obſervation are in this Caſe upon the ſame Side of the Equator.



Example 1. Suppoſe on the fourth Day of *July*, 1769, I obſerved the Meridian Altitude of the Sun to be 82°, 4′; conſequently the Zenith Diſtance 7°, 56′: Required the Latitude of the Place of Obſervation, and which Way it is.

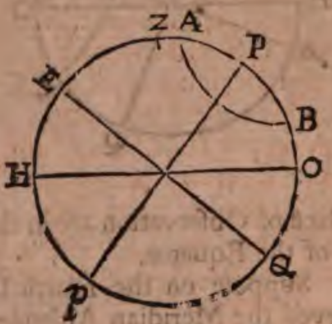
The Sun's Declination that Day is -	22°, 52′ N.
his Zenith Diſtance - - - - -	7°, 56′ N.
the Difference is the Latitude, *viz.* -	14°, 56′ N.

Example 2. Being at Sea, I obſerved the Meridian Altitude of the middlemoſt Star in the Tail of the Great Bear, to be 56°, 44′ North; conſequently it's Zenith Diſtance 33°, 16′, and it's Declination being 56°, 22′ North: Required the Latitude of the Place of Obſervation, and which Way it is.

From the Declination - - - - -	56°, 22′ N.
take the Zenith Diſtance - - -	33°, 16′ N.
there remains the Latitude - - -	23°, 06′ N.

Caſe 6.

Caſe 6. If the Sun or Star be between the Horizon and the elevated Pole, then to the Altitude add the Complement of the Declination, and the Sum will be the Latitude of the Place of Obſervation, and of the ſame Name with the Declination. For let A B be the Parallel deſcribed by the Object in it's diurnal Motion, B it's Place on the Meridian, when between the Horizon and elevated Pole; then 'tis plain, that if to B O the Altitude, be added B P the Complement of the Declination of the Object, the Sum P O will be equal to the Height of the Pole above the Horizon, which (by *Art.* 47. *Sect.* III.) is equal to the Latitude of the Place of Obſervation Z, and it will be of the ſame Name with the Declination, ſince both the Place and the Object are on the ſame Side of the Equator.



Example. Being at Sea, I obſerved the bright Star of the *Harp* on the Meridian, between the Horizon and elevated Pole, it's Altitude being 8°, 33′, and Declination 38°, 33′ North: Required the Latitude of the Place of Obſervation.

To the Complement of the Declinat.	51°, 27′ N.
add the Altitude - - - - - - -	8°, 33′ N.
the Sum is the Latitude - - -	60°, 00′ N.

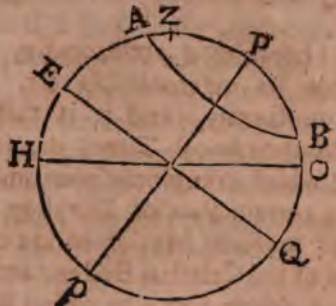
Caſe 7. When the obſerved Object does not ſet, and conſequently the Complement of it's Declination leſs than the Latitude of the Place; then, 'tis plain, the Object will be twice upon the Meridian in 24 Hours, *viz.* at it's leaſt and greateſt Altitude; when the Altitude is leaſt, the Object is then between the Horizon and elevated Pole, and by that Altitude and Declination of the Object, the Latitude of the Place may be found (as in the laſt Caſe); but when the Altitude is greateſt, the Object is then on the other Side of the Pole. Now with theſe two Meridian Altitudes, without knowing the Declination of the Object, we can find the Latitude of the Place, thus; if the two Altitudes be both on the ſame Side of the Zenith, then from the greater ſubtract the leſs, and half the Remainder added to the leſs gives the Latitude, of the ſame Name with the Zenith Diſtance; for in the preceding Scheme, where A B repreſented the Parallel of Declination, deſcribed by the Object in it's diurnal Motion, B O it's leaſt, and A O it's greateſt Meridian Altitude, 'tis plain, if from A O be taken B O, the Difference will be A B, whoſe half P B added to B O, gives P O the Height of the Pole above the Horizon, equal to the Latitude of the Place.

Example. Being at Sea, I obſerved the Northermoſt of the two preceding Stars in the Square of the *Great Bear*, which did not ſet, and found the leaſt Altitude to be 23°, 12′, and the greateſt 72°, 46′, both North of my Zenith: Required the Latitude of the Place of Obſervation.

From the greateſt Altitude - - -	72°, 46′ N.
take the leaſt - - - - - - - -	23°, 12′ N.
the Remainder is - - - - - -	49°, 34′
the half of which is - - - - -	24°, 47′
to which adding the leaſt Altitude -	23°, 12′
the Sum will be - - - - - - -	47°, 59′

which is equal to the Latitude of the Place, and it is North, becauſe the Zenith Diſtance is on the North Side.

But if the greateſt and leaſt Meridian Altitudes of the Object be upon different Sides of the Zenith, *viz.* one upon the North and the other upon the South Side; then from the Supplement of the greateſt Altitude ſubtract the leaſt, and half the Remainder added to the leaſt Altitude, will give the Latitude of the Place of Obſervation, which will be of the ſame Name with the leaſt Altitude, *viz.* North, if the leaſt Altitude be North of the Place, *& è contra.* For in the annexed Figure, let B A repreſent the Parallel deſcribed by the Object in it's diurnal Motion, B and A the Places of the Object when upon the Meridian, on contrary Sides of the Zenith Z; B O it's leaſt Altitude, and H A it's greateſt Altitude, the Supplement whereof is A O. Now if from A O we take O B, the Remainder will be A B, half of which, P B, added to B O, makes P O the Height of the Pole above the Horizon, or Latitude of the Place Z; which will be North if the leaſt Altitude B O be on the North Side of the Place, becauſe in this Caſe the North Pole will be elevated.



Example. Being at Sea, I obſerved the Sun when he did not ſet, and found his leaſt Meridian Altitude to be 3°, 29′ on the North Side of the Zenith, and his greateſt Meridian Altitude was 43°, 29′ on the South Side: Required the Latitude of the Place of Obſervation.

From the Supplement of the Sun's greateſt Meridian Altitude -	136°, 31′
take his leaſt Altitude - - - - - -	3°, 29′
and there remains - - - - - - -	133°, 02′
half of which is - - - - - - - -	66°, 31′
to which add the leſs Altitude - -	3°, 29′
the Sum is - - - - - - - - -	70°, 00′ N.

the Latitude of the Place of Obſervation.

SECT. V.

Of the Elements of Chronology.

1. TIME conſidered abſtractedly, without any Relation to external Objects, flows always equally and uniformly, and it is called Abſolute, True, and Mathematical Time, or, ſimply, *Duration.* But that which commonly goes under the Name of Time, is a certain Part of Duration meaſured by the ſimple and uniform Motion of ſome Body, ſuch as the Motion of the Celeſtial Bodies, and particularly of the Sun and Moon; this is called Relative, Apparent, or Vulgar Time.

2. Time is divided into Years, Months, Weeks, Days, Hours, Scruples or Minutes, *&c.*

3. A Day is of two Kinds, *viz. Natural* or *Artificial*; a *Natural Day* is that Space of Time that flows while the Sun moves from any Meridian, 'till he comes to the ſame again. An *Artificial Day*

is that Space of Time that the Sun continues above the Horizon, and the Time he continues below it is called a *Night.*

4. An *Hour* is a certain determinate Part of the Day, and is either *equal* or *unequal.* An *equal Hour* is the twenty-fourth Part of a natural Day; and an *unequal Hour* is the twelfth Part of an artificial Day, which is alſo called a *diurnal Hour*, as the twelfth Part of the Night is called a *noctурnal Hour*; theſe are likewiſe called *Temporary Hours*, becauſe at different Seaſons of the Year they are of different Lengths; for a diurnal Hour in the Summer is longer, and a nocturnal ſhorter, in the Winter; but in the equinoctial Day, a diurnal Hour is equal to a nocturnal, and then they are called *equinoctial Hours.*

5. The *diurnal Hours* begin at the Riſing and end at the Setting of the Sun; and the *nocturnal Hours* begin at the Setting and end at the Riſing of the Sun. Theſe Hours were antiently in Uſe among the *Jews* and *Romans*, and at preſent among the *Turks.* They were antiently called planetary Hours, becauſe in every Hour one of the ſeven Planets was ſuppoſed to preſide over the World; thus, for Example, on *Sunday*, the firſt Hour from Sun-riſing was allotted to the *Sun*, the ſecond fell to *Venus*, the third to *Mercury*, and ſo on to the reſt in Order, *viz.* to the *Moon*, *Saturn*, *Jupiter*, and *Mars*; by which Means, the firſt Hour from Sun-riſing, the next Day fell to the Moon; from which it was called *Monday*, and ſo on thro' the other Days of the Week, each Day getting it's Name from the Planet that was ſuppoſed to preſide the firſt Hour of that Day.

6. The Day in different Nations begins at different Times. Thus the *Babylonians*, *Aſſyrians*, and ſeveral other eaſtern Nations, began their Day at Sun-riſing; the Hour after that, they called the

firſt Hour, and ſo counted on 'till they came to the twenty-fourth or laſt Hour, which was the Hour before Sun-riſing. The *Jews* and *Grecians* began their Day at Sun-ſet; as at this Time the *Italians*, *Sicilians*, *Bohemians*, *Polanders*, and *Auſtrians* do; the Hour before the Sun-ſet they call the laſt or twenty-fourth Hour, and the Hour after the Sun is ſet, they call the firſt Hour; and ſo count on to the twenty-fourth, when the Sun ſets again.

7. The *Egyptians*, and *Romans*, antiently began their Day at Midnight; which was followed by *Hipparchus*, *Copernicus*, and other *Aſtronomers*, in their Aſtronomical Obſervations, and is ſtill retained in *Britain*, *France*, *Spain*, and moſt other Places in *Europe*; but the *Arabs*, and modern *Aſtronomers*, begin the Day at Noon, *viz.* when the Sun is upon the Meridian.

8. A *Week* is a Succeſſion of ſeven natural Days, each of which has a particular Name allotted to it, *viz.* the firſt is called *Sunday*, the ſecond *Monday*, and ſo on.

9. A *Month* is a certain Syſtem of Days, conſiſting of ſomething more or leſs than thirty Days, and is of two Kinds, *viz.* *Aſtronomical* or *Civil*; an *Aſtronomical* Month is that which is governed either by the Motion of the *Sun*, or that of the *Moon*; and conſequently is of two Kinds, *viz.* *Solar* or *Lunar*. A *Solar Month* is that Time which the Sun takes to run through a whole Sign, or the twelfth Part of the *Ecliptic*; and a *Lunar Month* is that which is meaſured by the Motion of the *Moon* round the Earth, and is of three Kinds, *viz.* *Periodical*, *Synodical*, and that of *Illumination*; the *Periodical* and *Synodical Months* are defined in *Art.* 45. *Sect.* III. and the *Month of Illumination* or *Apparition*, is that Space of Time contained between the Day that the *Moon* begins to appear after Change, to the Day that ſhe diſappears; and this

conſiſts of twenty-eight Days nearly. A *Civil* or *Political* Month, differs from the *Aſtronomical*, and conſiſts of more or fewer Days according to the Inſtitution of the Country in which they are uſed.

10. A *Year* is a certain Syſtem of Months, and is either *Aſtronomical* or *Civil*; the *Aſtronomical Year* is of two Kinds, *viz.* *Solar* or *Lunar*; and the *Solar Year*, is either *Sidereal* or *Tropical.* The *Sidereal Year* is that Space of Time that the *Sun* takes to move from a fixed Star 'till he returns to the ſame again; and it conſiſts of 365 Days, 6 Hours, 9 Minutes, and 14 Seconds; the *Tropical Year* is that Space of Time which flows while the *Sun* moves from any one of the *Cardinal Points*, 'till he returns to the ſame again; and it conſiſts of 365 Days, 5 Hours, 48 Minutes, and 57 Seconds, and commonly gets the Name of the *Solar Year.*

11. A *Lunar Year* conſiſts of a certain Number of Months, and is either *Common* or *Emboliſmic.* A *Common Lunar Year* conſiſts of twelve *Synodic Lunations*, and an *Emboliſmic* contains thirteen.

12. The *Civil* or *Political Year* conſiſts of a certain Number of Days, more or fewer, according to the Laws and Cuſtoms of the Countries in which it is received.

13. Since the *Common Lunar Year* conſiſts of twelve *Synodic Months*, or 354 Days nearly, and the *Solar* conſiſts of 365 Days, (throwing away the odd Hours and Minutes) 'tis plain that the *Solar Year* will exceed the *Lunar* by about 11 Days; and conſequently in the Space of about thirty-three Years, the Beginning of the *Lunar Year* will be carried thro' all the Seaſons; and hence it is called the *Moveable Lunar Year.* This Form of the Year is uſed at this Time by the *Turks* and *Arabians*; and becauſe in three Years Time, the *Solar* exceeds the *Lunar* by 33 Days; therefore to keep

the *Lunar Months* in the ſame Seaſons and Times of the *Solar Year*, or near it, they added a whole Month to the *Lunar Year*, every third Year, and ſo made it conſiſt of thirteen Months; this Year they called the *Emboliſmic Year*, and the additional Month, the *Embolimean*, or *Intercalary Month*. This Form of the Lunar Year is called the fixed *Lunar Year*; and it was uſed by the *Greeks* and *Romans* 'till *Julius Cæſar*'s Time.

14. The *Egyptians* made Uſe of the *Solar Years*, and made each conſiſt of 365 Days, which wants of the *Tropical Year*, almoſt 6 Hours; and conſequently the *Egyptian* Year began always 6 Hours ſooner than the *Tropical Year*; by which Means in four Times 365 or 1460 Years, (called the *Great Canicular Year* or *Sothiacal Period*) the Beginning of the Year moved through all the Seaſons.

15. *Julius Cæſar*, in order to reduce the *Civil* or *Political* Year nearly to an Equality with the *Tropical*, and conſidering that the *Tropical Year* conſiſted of 365 Days, and 6 Hours nearly, which exceeded the *Civil Year* by 6 Hours each Year, and conſequently in four Years exceeded by one whole Day; he ordered, that to every fourth Year there ſhould be one Day added, and ſo make it conſiſt of 366 Days, by which Means the *Civil* and *Solar Years* were reduced pretty near to an Equality. This additional Day was put in the Month of *February*, and becauſe in the common Year, the twenty-fourth Day of *February* was called by the *Romans* the ſixth of the *Kalends of March*, therefore he ordered that this Day ſhould be added after the twenty-fourth Day of *February*, and called by the ſame Name; there happening every fourth Year two Sixths of the *Kalends of March*, and hence that Year was called *Biſſextile* or *Leap Year*. This Way was uſed by us 'till the Year 1752, when the New Style commenced.

16. But the true Length of the Year being 365 Days, 5 Hours, and 49 Minutes nearly, and by the

Julian Account 365 Days and 6 Hours; 'tis plain the *Civil Year* exceeds the *Solar* by 11 Minutes nearly. Conſequently if the *Sun* any Year enters the *Equinoctial* on the twentieth Day of *March* at Noon, the next Year, he will enter the *Equinoctial* the ſame Day, 11 Minutes before Noon, the next, 22 Minutes before Noon, and ſo on. Conſequently in 131 Years the *Solar* will anticipate the *Civil Year* by one whole Day; and ſo either *Equinox* will not happen always on the ſame Day of the *Civil Year*, but be carried in a retrograde Order through all the Days of it. This put Pope *Gregory* XIII. upon reforming the *Julian* Kalendar; for finding that at the Time of the *Nicene Council*, when the Time of celebrating *Eaſter* was inſtituted, the vernal *Equinox* happened the twenty-firſt Day of *March*, and by flowing continually backwards, it happened at his Time, in the Year 1572, on the 11th Day of *March*, anticipating it's former Time by 10 whole Days; he ordered that theſe 10 Days ſhould be taken out of the *Kalendar*, and the 11th Day of *March* ſhould be reckoned the twenty-firſt; and to prevent the Seaſons of the Year from going any more backwards, as they were before, he ordered that every hundredth Year of the *Chriſtian Æra* (which according to the *Julian Kalendar* is *Biſſextile*) ſhould be a common Year, and ſo conſiſt only of 365 Days; but this being too much, therefore every four hundredth Year was to remain *Biſſextile* or *Leap Year*. But ſince his Time to the Year 1752, one Day more has been anticipated, which was the Reaſon that eleven Days were ordered to be taken out of the Kalendar in the Month of *September* 1752, when the New Style commenced in theſe Kingdoms. The *Julian* Form is called *Old Style*, and the *Gregorian*, *New Style*.

17. A *Kalendar* is a regular Diſpoſition of the Days in the *Civil Year*, into Months and Weeks; each Day of every Week being diſtinguiſhed from another by one of the firſt ſeven Letters of the Alphabet, *viz.*

A,

A, B, C, D, E, F, G. Beginning at the firſt of *January*, to it is annexed the Letter A, to the ſecond the Letter B, to the third C, and ſo on to the ſeventh, to which is annexed the Letter G; and beginning again with the Letters, to the eighth is annexed A, to the ninth B, to the tenth C, and ſo on thro' the reſt of the Days of the Year, each of them having one of theſe Letters annexed to it. Hence 'tis plain that whatever Letter is placed againſt any Day of any Week; that Letter will be placed againſt that Day through the whole Year: Thus if the firſt Day of *January*, againſt which ſtands the Letter A, be a *Sunday*; then all the Days in the *Kalendar* having the Letter A ſtanding againſt them will be *Sundays*. Alſo if the fourth Day of *January*, againſt which ſtands the Letter D, be a *Sunday*, then all the Days in the *Kalendar*, having D annexed to them, will be *Sundays*. That Letter which anſwers to the *Sundays* throughout the Year, is called the *Dominical* or *Sunday Letter*, for that Year.

But ſince the *Common Year* conſiſts of 365 Days, if that be divided by ſeven, the Quotient will be 52 Weeks, and one Day over; and ſince if nothing remained, then whatever Day of the Week the Year began on, the ſame Day of the Week would be the firſt Day of each ſucceeding Year; therefore whatever Day of the Week any Year begins on, the ſame Day of the Week will be the laſt Day of the Year; and, conſequently, if the firſt Day of *January*, to which is annexed the Letter A, be *Sunday*, the laſt Day of the Year will be *Sunday*, and the firſt of the next will be *Monday*, and the firſt *Sunday* of the Year will fall on the ſeventh Day, to which is annexed the Letter G, which therefore will be the *Dominical Letter* all that Year; and ſince the Year began on *Monday*, it will alſo end on *Monday*, and the firſt Day of the next Year will be *Tueſday*; conſequently the firſt *Sunday* will fall on the ſixth Day, to which is annexed F, which therefore will be the *Dominical Letter* all that

Year. And the ſame Way the *Dominicul Letter* the Year following will be E, and for the next D; and in this retrograde Order the *Dominical Letter* is carried ſucceſſively thro' the ſeven, after which it begins again.

18. From what has been ſaid 'tis plain, that if the Year conſiſted of 365 Days exactly, after a Period of ſeven Years, the ſame Day of each Month would fall on the ſame Day of the Week. But becauſe every fourth Year is *Biſſextile*; conſiſting of 366 Days, which is equal to 52 Weeks, and 2 Days; therefore if that Year begins on a *Sunday*, it will end on *Monday*, and the next will begin on *Tueſday*, and the firſt *Sunday* of that Year will fall on the ſixth Day of *January*, to which is annexed the Letter F, which will be the *Dominical Letter* for the Year following the *Leap Year*, whoſe *Dominical Letter* was A. And ſince the *Biſſextile* or *Leap Year* returns every fourth Year, 'tis plain the Series of *Dominical Letters* will be interrupted, and will not return 'till after four Times ſeven, or twenty-eight Years. And hence ariſes the Cycle of twenty-eight Years, called the *Solar Cycle*, which being compleated, the Days of the Month return in the ſame Order to the ſame Day of the Week.

19. And ſince in every *Leap Year*, the *Intercalary* Day is placed between the twenty-third and twenty-fourth Days of *February*, and ſo makes two twenty-fourths of *February*; which in the *Kalendar* are eſteemed as one and the ſame Day, and have the ſame Letter affixed to them, and which by our Way of Reckoning are called the twenty-fourth and twenty-fifth Days of *February*; 'tis plain the Order of the *Dominical Letter* will at that Time be interrupted, and the ſucceeding Letter will take Place; thus if in a *Leap Year* the firſt of *January* be *Sunday*, and conſequently the *Dominical Letter* A; the 24th Day of *February* will fall upon a *Friday*, and the twenty-fifth on a *Saturday*; and ſince both theſe Days are marked in the *Kalendar* with the ſame Letter F; the following Day,

which is *Sunday*, will be marked with G, which Letter will mark out all the *Sundays*, and conſequently be the *Dominical Letter*, the remaining Part of the Year. And hence it is, that every *Leap Year* has two *Dominical Letters*, the firſt of which ſerves from the Beginning of the Year to the twenty-fourth or twenty-fifth Day of *February*, and then the other takes Place, and ſerves for the reſt of the Year. And hence ariſes the Cycle of twenty-eight Years, generally called the *Cycle of the Sun*; and may be found by adding 9 to the given Year, and dividing the Sum by 28; for the Quotient will ſhew the Number of Cycles, that have elapſed ſince the Beginning of the Chriſtian Æra; and the Remainder the current Year of the Cycle.

And hence we have the following general Rule for finding the Dominical Letter, according to the *Julian* Method of Computation. Add to the Year it's fourth Part, and 4, and divide that Sum by 7; if nothing remains the Dominical Letter is G, but if any Remainder, it ſhews the Letter in a retrograde Order from G; or if it be ſubtracted from 7, you will have the Index of the Letter from A. Reckoning for 1, A; for 2, B; for 3, C; *&c.*

20. But by the Reformation of the *Kalendar* under Pope *Gregory*, the Order of the *Dominical Letters* was interrupted in the *Gregorian* Year: For the Year 1582, which at the Beginning had G for it's *Dominical Letter*, by retrenching 10 Days after the fourth of *October*, came to have C for it's *Dominical Letter*; and by having but one *Dominical Letter* for the Year 1700, the *Dominical Letter* of the ancient *Julian* Kalendar is four Places before that of the *Gregorian*; whence to find the *Dominical Letter* according to the *Gregorian* Year, or New Style, we muſt uſe the following Rule:

Divide the Year and it's fourth Part by 7, and ſubtract the Remainder from 7, and you will have the Index of the *Dominical Letter*, as before.

Example. Let it be required to find the *Dominical Letter* for the Year 1772.

I add to the given Year it's fourth Part, *viz.* 443, and divide that Sum, namely 2215 by 7, and the Remainder is 1, which being ſubtracted from 7, leaves 6; the Index of the Letter F.

But becauſe the Years 1800, 1900, 2100, 2200, 2300, *&c.* according to the New Style, conſiſt only of 365 Days, and conſequently have but one *Dominical Letter*, which according to the *Julian* Account would have had two, therefore the above Rule will not find the *Dominical Letter* any longer than the Year 1799.

21. Since the Revolutions of the *Sun* and *Moon* are found conſtantly to be the ſame, the *Moon* moving with about thirteen Times the Velocity of the *Sun*; it follows, that after a certain Number of Revolutions, they muſt meet again in the ſame Point of the Heavens they did ſome Time before, which by *Meton* the *Athenian*, was ſaid to be 19 Years juſt; after the Expiration of which Time, the *new* and *full Moons* were ſuppoſed to happen on the ſame Day and Time of that Day, and in the ſame Month, they did 19 Years before that. This *Cycle* is from it's Author called the *Metonic Cycle*; alſo 'tis called the *Lunar Cycle.*

22. This *Cycle* began 1 Year before the Commencement of the *Chriſtian Æra*, and conſequently to find what Year of the *Cycle* any Year in the *Chriſtian Æra* is; we muſt to the given Year add 1, and divide the Sum by 19; then the Quotient will ſhow how many *Cycles* have revolved ſince the Commencement of the *Chriſtian Æra*, and the Remainder will ſhew what Year of the *Cycle* the preſent Year is; if there be no Remainder, then the given Year will be the laſt or nineteenth Year of the *Cycle*. The Year of the *Cycle* anſwering to any given Year, is, for it's great Uſe in determining the Times of the *new* and *full Moon*,

and thereby knowing what Day of the Month *Eaſter Day* falls upon, called the *Golden Number* or *Prime* for that Year.

Example. Required the *Golden Number* for the Year 1772.

Firſt, I add 1 to the given Year, and the Sum is 1773, this divided by 19, gives 93 for the Quotient, and 6 for the Remainder; which ſhows that there has revolved 93 compleat *Lunar Cycles* ſince the firſt Year of that *Cycle* in which the *Chriſtian Æra* commenced, and that the given Year is the 6th Year of the current *Cycle*, conſequently 6 is the *Prime* or *Golden Number* for the Year 1772.

23. It has been ſhewn, at *Art.* 13. of this, that the *Solar Year* exceeds the *Lunar* by 11 Days nearly; conſequently if the Moon be new, or in Conjunction with the Sun, on the laſt Day, or thirty-firſt of *December* in any Year, on the laſt Day of the next Year it will be 11 Days paſt Conjunction, and on the laſt Day of the following Year it will be 22 Days after new Moon; but becauſe in the ſucceeding Year this amounts to 33 Days, and 30 Days being allowed for a compleat Moon; 'tis plain, in that Year there will have happened 13 Conjunctions, and the Moon will be 3 Days paſt Change on the laſt Day of it; conſequently on the laſt Day of the next Year the Moon will be 14 Days paſt the Conjunction, and ſo continually increaſing by eleven Days yearly, 'till after the End of 19 Years it will become the ſame as before. The Age of the Moon, or Number of Days paſt ſince the Conjunction, on the laſt Day of any Year, is called the *Epact* for the ſucceeding Year.

24. Now ſince the *Epact* for the firſt Year of the *Lunar Cycle* was 11, the *Epact* for the Second will be 22, for the Third 3, for the Fourth 14, for the Fifth 25, and ſo on conſtantly increaſing by 11; it follows that to find the *Epact* for any Year, we muſt multiply the *Golden Number* for that Year by 11,

and divide the Product by 30, and the Quotient, if there be any, will ſhew how many *Embolimean* or *Intercalary* Months have happened ſince the firſt Year of the current *Cycle*, and the Remainder will be the *Epact* for the given Year; or will ſhew how many Days have elapſed between the laſt Day of the former Year, and the immediately preceding Conjunction.

But the Epact thus found will be that for the *Julian* Year; and therefore to find the *Gregorian* Epact, or that of the New Style, we muſt ſubtract from the *Julian* Epact, the Number of Days it has anticipated (Art. 16.) and the Remainder will be the *Gregorian* Epact required.

Example. Required the *Gregorian* Epact for the Year 1772.

Firſt, I find the *Julian* Epact 6 for the Year 1772, to which add 30 we have 36, from this I ſubtract 11, the Number of Days anticipated, and the Remainder 25, is the *Epact*, or Age of the Moon the laſt Day of *December* 1772 required. *Note*, after the Year 1800, the *Julian* Account will have anticipated 12 Days, and conſequently 12 muſt be ſubtracted from the *Julian* Epact.

25. Since by *Art.* 23. the *Epact* for any Year ſhews the Age of the *Moon* on the laſt Day of the preceding Year, therefore, if to the *Epact* we add 1, the Sum will be the Age of the *Moon* the firſt Day of that Year; but becauſe the *Synodical* Month, or Time between any two immediate Conjunctions, is equal to 29 Days and an Half, and *January* containing 31 Days; therefore if to the Age of the *Moon* on the firſt of *January* be added $1\frac{1}{2}$ or (to avoid Fractions) 2 Days, the Sum will be the Age of the *Moon* on the firſt of *February*; and becauſe in common Years the Days in *January* and *February* taken together make 59, which is exactly equal to two entire Lunations, therefore the Age of the *Moon* on the firſt of *January*

January will be the ſame with it's Age on the firſt of *March*, and conſequently to it's Age on the firſt of *January*, there is nothing added, in common Years, for it's Age on the firſt of *March*; but in *Leap Years* the Sum of the Days in *January* and *February* being 60, which is more than two entire *Lunations* by 1 Day, it is evident that in this Caſe, we muſt add 1 Day to the *Moon*'s Age on the firſt of *January*, and the Sum will be it's Age on the firſt of *March*. And by the ſame Way of Reaſoning it will appear, that to find the Age of the *Moon* on the firſt Day of any Month, we muſt add to it's Age on the firſt of *January* the following Numbers, *viz.* for *February* 2, for *March* 0, in common Years, and 1 in Leap Years, for *April* 2, for *May* 3, for *June* 4, for *July* 5, for *Auguſt* 6, for *September* 8, for *October* 8, for *November* 10, and for *December* 10. Theſe additional Numbers are called the *Numbers* of the *Months*.

26. From what has been ſaid in the two laſt Articles, there naturally follows this Rule for finding the *Age of the Moon* on any Day of a given Year, *viz.* To the *Epact* for the given Year, add the Day of the Month and Number of the Month, and if the Sum be leſs than 30 it is the Age of the *Moon* required; but if it exceed 30 then take 30 from it, and the Remainder is the *Moon*'s Age.

Example. Required the *Moon*'s Age on the 23d Day of *May* 1770.

Firſt, by *Art.* 24. I find the *Epact* for that Year to be 3, to which adding 23 the Day of the given Month and 3 the Number of it, the Sum is 29, the *Moon's* Age on the given Day.

27. Since the *Moon* takes 30 Days from one Conjunction with the Sun to the next following, 'tis plain ſhe muſt be 15 Days old when *Full*, and $7\frac{1}{2}$ when in the firſt *Quarter*; and $22\frac{1}{2}$ Days old when in the laſt *Quarter*. Conſequently to find in any Month of a

given Year the Day of the *Moon*'s *Change*, and when *Full*, and when in either *Quarter*, we have this Rule, *viz.* Aſſume any Day of that Month at Pleaſure, and by the laſt *Art.* find the Age of the *Moon* on that Day; then if it be 15 the *Moon* will be full that Day, and counting 7 ½ Days backwards and forwards from that Day, you'll have the Times of the firſt and laſt *Quarters*, and by counting backwards and forwards from it 15 Days, you'll have the Times of the laſt and next *Change*. But if the Age of the *Moon* be greater than 15, then take 15 from it, and the Remainder will ſhew how many Days have run ſince laſt *Full Moon*. So counting thoſe backwards you'll have the Day the laſt *Full Moon* happened on; and by knowing that, we can find the Days of the *Change* and either *Quarter* as before. Again, if the Age of the *Moon* on the aſſumed Day be leſs than 15, then take that from 15, and the Remainder will ſhew how many Days are to run 'till the next *Full Moon*; and therefore counting ſo many forwards, you will have the Day of the *Full Moon*, by which you may find the Days of the *Change* and either *Quarter* as above.

Example. Required the Times of *Full Moon*, *New Moon*, and firſt and laſt *Quarters* in *October* 1770.

Firſt, I aſſume any Day at Pleaſure, ſuppoſe the ſeventh of that Month; then by the laſt *Art.* I find the *Moon*'s Age on that Day to be 18 Days, from which taking 15 there remains 3, the Number of Days ſince the laſt *Full Moon*; therefore counting ſo many Days backwards, I find the *Full Moon* happens on the fourth Day of *October*, and counting 7 ½ Days forwards from that, I find that the laſt *Quarter* happens on the eleventh Day; then from the fourth Day, on which the *Full Moon* happens, counting 15 Days forwards, I find that the *Change* falls on the 19th Day, and reckoning 17 ½ Days forward from that, I find that the firſt *Quarter* falls on the twenty-ſixth Day.

28. When the *Moon* is in *Conjunction* with the *Sun*, then they both come to the Meridian at the ſame Time; but the *Moon* moving ſtill Eaſterly with a Velocity much greater than that of the *Sun*, 'tis evident that when the *Sun* comes on the Meridian the next Day, the *Moon* will be on the Eaſt Side of it, and conſequently cannot be on the Meridian 'till ſome Time after the *Sun*; and becauſe ſhe compleats her Revolution in 30 Days, therefore in that Period, the Difference of Time between the *Sun* and *Moon*'s being on the Meridian will run through the whole 24 Hours: And hence by obſerving any Day how long Time the *Moon* takes to be upon the Meridian after the *Sun*, we may by this find the Age of the *Moon* that Day, making the following Proportion, *viz.* As 24 Hours, the whole Difference of Time, is to 30 Days, the whole Number of Days from *Change* to *Change*, So is the obſerved Difference of Time on any Day, to the Days run ſince the laſt *Change*, or the Age of the *Moon* at that Time.

Example. Suppoſe on any Day the *Moon* is obſerved to be upon the Meridian 5 Hours after the *Sun*; Required the Age of the *Moon* at that Time. Make it, as 24 is to 30, ſo is 5 to $6\frac{1}{4}$; conſequently the *Moon* is $6\frac{1}{4}$ Days old at the Time of Obſervation.

29. The *Moon* moving round her Orbit, of 360 Degrees, in 30 Days; ſhe muſt move 12 Degrees in 1 Day; but ſince her Motion is from Weſt to Eaſt, and any Heavenly Body, 15 Degrees to the Eaſtward of another, being 1 Hour later in coming to the Meridian than that other; therefore making it as 15 Degrees is to one Hour, ſo is 12 Degrees to $\frac{4}{5}$ of an Hour, or 48 Minutes; we find that the *Moon* is always 48 Minutes later of coming to the Meridian any Day than ſhe was the Day before; and becauſe ſhe comes on the Meridian at the ſame

Time with the *Sun* on the Day of her *Change*; therefore to find her *Southing*, or Time of her coming on the Meridian, any Day, we muſt firſt find her Age (by *Art.* 26.) for that Day, then this multiplied by 48, will give the Minutes of Difference of Time between the *Sun* and *Moon*'s coming on the Meridian; which, divided by 60, will ſhew how many Hours and Minutes the *Moon* is later of coming on the Meridian than the *Sun*; and counting ſo many forward from twelve of the Day, we have the Time of the *Moon*'s *Southing*. If the Hours and Minutes found as above be leſs than 12, then that will be the Time of the *Moon*'s *Southing after Noon*; but if greater than 12, then take 12 from them, and the Remainder will be the Time of the *Moon*'s *Southing* in the *Morning*.

Example. Required the Time of the *Moon*'s *Southing* on the 17th of *October* 1770.

Firſt, (By *Art.* 26.) I find the Age of the *Moon* that Day to be 28 Days, which multiplied by 48 gives 1344 Minutes, for the Difference of Time between the *Sun* and *Moon*'s coming to the Meridian that Day; and this divided by 60 gives 22 Hours and 24 Minutes; which being more than 12 Hours, ſubtract 12, the Remainder is the Time of the *Moon*'s *Southing in the Morning*.

Example 2. Required the Time of the *Moon*'s *Southing* the 7th Day of *May* 1770.

Firſt, (By *Art.* 26.) I find the *Moon*'s Age to be 13 Days, which multiplied by 48 gives 622 Minutes, the Difference of Time between the *Sun* and *Moon*'s being on the Meridian that Day, and this reduced makes 10 Hours and 22 Minutes; this ſhews that on the 7th of *May* 1770, the *Moon* comes on the Meridian at 22 Minutes paſt 10 at *Night*.

30. It was ſaid at *Art.* 20. of this, that the firſt Year of the *Solar Cycle* was *Leap Year*; conſequently

the fifth muſt be *Leap Year*, and the ninth muſt alſo be *Leap Year*; but the *Chriſtian Æra* commencing on the tenth Year of the *Solar Cycle*, therefore the firſt Year of that was the firſt after *Leap Year*, and the fourth was *Leap Year*, alſo the eighth, twelfth, ſixteenth, *&c.* were *Leap Years*; whence to find whether any propoſed Year of the *Chriſtian Æra* be *Leap Year*, or how many it is paſt the laſt *Leap Year*; we muſt divide the propoſed Year by 4, and if nothing remain, then the propoſed Year is *Leap Year*; but if any Thing remain, that will ſhew how many Years have paſt ſince laſt *Leap Year*. But remember, that in the New Style, the Years 1800, 1900, 2100, *&c.* are reckoned as common Years, whereas by the above Method of Computation they would be *Leap Years*.

Example. Required whether the Year 1770 be *Leap Year*, or how many ſince laſt *Leap Year*.

I divide the propoſed Year 1770 by 4, and there remains 2, ſo I conclude that the Year 1770 is the ſecond after *Leap Year*.

31. It has been ſhewn at *Art.* 17. of this, that to every Day of the Year there is annexed one of the firſt ſeven Letters of the Alphabet, beginning with A, which is always annexed to the firſt of *January*, and in any common Year, the Letter annexed to the firſt *Sunday* in *January* is called the *Dominical Letter* for that Year; but each *Leap Year* having two *Dominical Letters* (by *Art.* 19.) the firſt of which ſerves from the Beginning of the Year to the twenty-fourth or twenty-fifth of *February*, and the other for the reſt of the Year; conſequently the *Dominical Letter* for any common Year, will ſhew what Day of *January* the firſt *Sunday* of that Year happens upon, reckoning from A (which is annexed to the firſt of *January*) according to the natural Order of the Letters, and in any *Leap Year* the firſt of it's two *Dominical Letters* will ſhew what Day of *January* the firſt *Sunday* of that Year falls on, counting from A, as

above; thus in the Year 1770 the *Dominical Letter* is G, ſo counting from A, *viz.* making A 1, B 2, C 3, D 4, E 5, F 6, and G 7, I find that the firſt *Sunday* of that Year falls on the ſeventh Day of *January*; and by knowing what Day of *January* the firſt *Sunday* of any Year falls on, we may know what Day of the Week the firſt Day of that Year falls upon, by counting ſo many Days back from *Sunday*; thus, ſince in the Year 1770, the firſt *Sunday* falls upon the ſeventh of *January*; therefore the firſt will be *Monday*; conſequently the Year 1770 begins upon *Monday*. From what has been ſaid, there ariſeth the following Rule for finding what Day of the Week any Day of a given Year falls upon, *viz.* Find the Day of the Week anſwering to the firſt of *January* that Year; then add together the Days contained in each Month from the Beginning of the Year to the Month in which the propoſed Day is, and to this add the Day of the given Month: *Laſtly*, Divide this Sum by 7, and if nothing remain, then the Day of the Week, preceding that Day which anſwers to the firſt of *January* that Year, is the Day anſwering to the propoſed Day; but if any Thing remain, then counting ſo many forward (beginning with that Day the firſt of *January* falls on) we ſhall have the Day of the Week the propoſed Day falls upon. *Note*, The Days contained in each Month, are as follow, *viz.* *January* 31, *February* 28 in common Years, and 29 in *Leap Years*, *March* 31, *April* 30, *May* 31, *June* 30, *July* 31, *Auguſt* 31, *September* 30, *October* 31, *November* 30, *December* 31.

Example. Required what Day of the Week the eighth of *July* 1770 falls upon.

Firſt, By the preceding Rule in this *Article*, I find that the firſt of *January* 1770 falls upon a *Monday*; then to the Sum of 31, 28, 31, 30, 31, 30, anſwering to the elapſed Months, I add 8 the Day of the given Month, and their Sum 189 I divide by 7, and as there is no Remainder, I conclude that the eighth of *July* 1770 falls upon a *Sunday.*

Example 2. Required what Day of the Week the twenty-firſt of *March* 1770 falls upon.

By proceeding as in the laſt Example, I find after Diviſion that 3 remains, and the Year beginning upon a *Monday*, therefore counting *Monday* 1, *Tueſday* 2, and *Wedneſday* 3, I find that the propoſed Day falls upon *Wedneſday.*

32. According to the Decree of the *Nicene Council* (which is followed by the Church of *England)* the *Sunday* after the fourteenth Day of that *Moon* which happens upon or after the twenty-firſt of *March*, *i. e.* after the Commencement of the twenty-firſt of *March*, is *Eaſter-Sunday.* And ſince the fourteenth Day of that *Moon*, or the *Paſchal Full Moon*, can never happen before the twenty-firſt of *March*, nor after the eighteenth of *April*; therefore *Eaſter-Day* can never happen ſooner than the twenty-ſecond of *March*, nor later than the twenty-fifth of *April.* Now to find what Day of *March* or *April Eaſter-Day* falls upon in any Year, we have, from the foregoing *Articles*, the following Rule, *viz. Firſt* (by *Art.* 26.) find the Age of the *Moon* on the twenty-firſt of *March* that Year, and if it be 14, then by the laſt *Article* find the Day of the Week anſwering to it, and the *Sunday* following is *Eaſter-Day*; but if the *Moon*'s Age on the twenty-firſt of *March* be not 14, then reckon forward to the Day in which her Age is 14, and by the laſt *Article*, find the Day of the Week anſwering to that Day, and reckoning forward to the next *Sunday*, we ſhall have the Day required.

Example. Required when *Eaſter-Day* happens in the Year 1770.

Firſt, I find (by *Art.* 26.) that the Age of the *Moon* on the twenty-firſt of *March* 1770 is 24, conſequently counting 19 forward, I find that the 14th Day of the *Moon*, or the *Paſchal Full Moon*, happens on the eleventh Day of *April*; then (by *Art.* 31.) I find that the eleventh of *April* 1770, is *Wedneſday*; therefore counting forwards to the next *Sunday*, which is *Eaſter-Day*, I find it happens on the 15th of *April*. *Note*, In *Leap-Years*, inſtead of the twenty-firſt of *March*, you muſt uſe the twentieth; becauſe in theſe Years *February* is increaſed by 1 Day.

33. From the *Cycles* of the *Sun* and *Moon* (explained in *Art.* 18. and 21.) multiplied into one another, there ariſes another *Cycle* of 532 Years, called the *Victorian* or *Dionyſian Cycle*, from *Dionyſius* it's Author; after the compleating of which, not only the *New Moons* and *Full Moons* return to the ſame Day of the Month nearly; but likewiſe the Days of every Month return to the ſame Days of the Week; and conſequently the *Dominical Letters*, and all the *Moveable Feaſts*, return in the ſame Order: Whence this *Cycle* is called *The Great Paſchal Cycle*. Now, becauſe the *Chriſtian Æra* commenced on the 457th Year of the *Cycle*; therefore to find the Year of the *Dionyſian Period* for any Year of the *Chriſtian Æra*, we have the following Rule, *viz.* To the current Year of the *Chriſtian Æra*, add 457, and divide the Sum by 532; then the Quotient will ſhew how many *Periods* have paſt ſince the Beginning of that in which the *Chriſtian Æra* commenced, and the Remainder will ſhew the *Æra* of the *Dionyſian Period* anſwering to the given Year.

Example. Required the Year of the *Dionyſian Period* for the Year of *Chriſt* 1770.

Firſt, I add to 1770 the Number 457, and the Sum is 2227; then I divide this by 532, and the Quotient is 4, and Remainder 99; conſequently there has paſt 4 *Dionyſian Periods* ſince the Beginning of that in which the *Chriſtian Æra* commenced, and the given Year is the 99th of the *Current Cycle*.

34. Beſides the *Cycles* of the *Sun* and *Moon*, there is another *Cycle* conſiſting of 15 Years, called the

Cycle of *Indiction*, which hath no Connection with the Celeſtial Motions, and which was made uſe of by the *Romans* for ſome *Civil* Purpoſes, and is ſtill uſed by the *Popes of Rome* in their *Bulls* and *Diplomas*. The Year before *the Birth of Chriſt* was the third Year of this *Cycle*; and conſequently to find the Year of *Indiction* for any Year in the *Chriſtian Æra*, we have this Rule, *viz.* to the given Year add 3, and divide the Sum by 15, then if there be no Remainder, the given Year is the fifteenth of the *Indiction*; but if there be any Remainder, that will ſhew what Year of the *Indiction* the given Year is; and the Quotient will ſhew how many compleat *Cycles of Indiction* has paſt ſince the firſt Year of that in which the *Chriſtian Æra* commenced.

Example. Required the Year of *Indiction* for the Year 1770 of the *Chriſtian Æra.*

Firſt, I add 3 to the given Year, and the Sum is 1773; then I divide this Sum by 15, and the Quotient is 118, and Remainder 3. Conſequently there has been 118 compleat *Cycles of Indiction* from the firſt Year of that in which the *Chriſtian Æra* commenced, and the Year 1770 is the 3d Year of *Indiction.*

35. From the Multiplication of the three *Cycles*, *viz.* the *Solar* of 28 Years, the *Lunar* of 19, and that of *Indiction* of 15, ariſes a Period of 7980 Years, called the *Great Julian Period*. This is ſuppoſed to have begun 764 Years before the *Creation of the World*, and is not yet compleated; conſequently it muſt comprehend all the Actions that have happened from the Beginning of the World; and ſince the Year before *Chriſt* was the 4713th Year of this *Period*, therefore to find what Year of the *Julian Period* any current Year is, we muſt to the given Year of *Chriſt* add 4713, and the Sum will be the required Year of the *Julian Period.*

Example. Required what Year of the *Julian Period* anſwers to the current Year of *Chriſt*, 1770.

To the given Year 1770, I add 4713, and the Sum 6483 ſhews that the current Year of *Chriſt*, 1770, is the 6483d Year of the *Julian Period*.

36. As in the Heavens there are certain Points from which *Aſtronomers* begin their Computations, ſo likewiſe there are certain Points of Time from which, as *Roots*, *Chronological* Computations begin; and all memorable Actions are recorded by *Hiſtorians* according to the Series of Years following theſe *Roots*, or fixed Points of Time, which are called *Epochas*, or *Æras*. The moſt celebrated and beſt known to us, is the *Chriſtian Æra*, which commenced on the firſt of *January*, immediately following the Birth of *Chriſt*.

37. The moſt ancient *Epocha* is that of the Creation of the World, which commenced 3950 Years before *Chriſt*. The next to this is that of the *Deluge*, which began 2956 Years before *Chriſt*. Then follows the *Epocha* of the *Olympiads*, which was the moſt ancient and famous *Epocha* among the *Greeks*, and other *Eaſtern Nations*; each *Olympiad* contained 4 Years, and they had their Riſe from certain Games that were celebrated by the *Grecians* every fourth Year, in Honour of *Jupiter Olympius*, which were called *Olympick Games*. The Beginning of this *Epocha* is ſuppoſed to have been in the 777th Year before *Chriſt*, and in the 3936th Year of the *Julian Period*. The next *Epocha* is that of the Building of *Rome*, which began about the End of the third Year of the *Sixth Olympiad*, 754 Years before *Chriſt*, and in the 3959th Year of the *Julian Period*. Then follows the *Æra of Nabonaſſar*, *King of Babylon*, from the Beginning of whoſe Reign it commenced. This *Æra* is famous among *Aſtronomers*, being made uſe of by *Ptolemy*, *Albategnus*, &c. as a proper *Æra* for computing the Motions of the Celeſtial Bodies from. It began, according to *Ptolemy*, on the fourth of the *Kalends* of *March*, 747 Years before *Chriſt*, in the 3966th Year of the *Julian Period*, and in the ſeventh Year after

the Building of *Rome*, and in the ſecond Year of the eighth *Olympiad*. The next is the *Epocha* of *Alexander the Great*, which commenced at his Death; and this happened about the Middle of the Spring, in the firſt Year of the 114th *Olympiad*, 324 Years before *Chriſt*, in the 4390th Year of the *Julian Period*, and in the 424th Year of the *Æra of Nabonaſſar*. There are ſeveral other *Epochas* beſides theſe already mentioned, of leſs Note, which I ſhall paſs over, it not being the Deſign here to give a particular Deſcription of all the *Epochas* and their ſeveral Uſes, but only to give a general Account of the moſt remarkable among them.

38. Since by the Rotation of the *Earth* about it's Axis, the *Moon* appears to move quite round from *Eaſt* to *Weſt* in 24 Hours; therefore in that Time ſhe muſt paſs over all the Points in the *Compaſs*, and ſo muſt move from one Point to the next ſucceeding in 45 Minutes. Conſequently in moving from the *North* Point to the *South* ſhe muſt take 12 Hours, and from the *North* to the N *b* E, or from the *South* to the S *b* W, 45 Minutes; alſo from the *North* to the N N E, or from the *South* to S S W, 1 Hour 30 Minutes; and ſo on, as in the following Table.

Points.	*h* ,, *m*	*Points.*
N	12 ,, 00	S
N *b* E	0 ,, 45	S *b* W
N N E	1 ,, 30	S S W
N E *b* N	2 ,, 15	S W *b* S
N E	3 ,, 00	S W
N E *b* E	3 ,, 45	S W *b* W
E N E	4 ,, 30	W S W
E *b* N	5 ,, 15	W *b* S
E	6 ,, 00	W
E *b* S	6 ,, 45	W *b* N
E S E	7 ,, 30	W N W
S E *b* E	8 ,, 15	N W *b* W
S E	9 ,, 00	N W
S E *b* S	9 ,, 45	N W *b* N
S S E	10 ,, 30	N N W
S *b* E	11 ,, 15	N *b* W

39. The *Flux* and *Reflux*, or *Ebbing* and *Flowing* of the Seas, do conſtantly reſpect the Motion of the *Moon*; and in every Place when the *Moon* is on a certain Point of the *Compaſs*, or at a certain Diſtance from the Meridian, it is then High-Water at that Place; and ſince ſhe is twice at the ſame Diſtance from the Meridian, or in two oppoſite Points of the *Compaſs*, in her diurnal Motion; therefore in moſt Places there is a double Ebbing and Flowing in a little more than 24 Hours. There has been found by Obſervation, for the moſt remarkable Coaſts, the Points on which the Moon is when it is High-Water in each of them, as in the following Table.

A Table of the moſt remarkable Sea-Coaſts, in an Alphabetical Order; ſhewing in each of them, the Points of the Compaſs *the* Moon *muſt be on, when it is High-Water.*

A.

AT *Aberwark*, E N E and W S W.

At *Abermerick* and *Antwerp*, E and W.

At *Aldborough*, S E *b* S, and N W *b* N.

At *Amſterdam* and *Armenties*, N E and S W.

At *Army*, N N E and S S W.

B.

At *Beachy* and *Blacktail*, and before the Race of *Blanquet*, N and S.

At *Blackneſs* in *Bluet*, at *Belle-Iſle*, N N E, and S S W.

Without *Bluet*, and at *Berwick*, N E *b* N, and S W *b* S.

At the River *Bourdeaux*, the South Coaſt of *Bretagne*, the Coaſt of *Biſcay*, and at *Bookneſs*, N E, and S W.

At *Breſt*; before the *Baſs*, the River of *Bourdeaux* within the *Haven*, N E *b* E, and S W *b* W.

In the *Breeſound*, *Bloy*, *Baltimore*, E N E, and W S W.

Before *Bremen*, and at *Blackney*, and in the Channel before *Bourdeaux*, E and W.

At *Bridgewater*, E S E, and W N W.

At *Briſtol-Key*, E *b* S, and W *b* N.

At *Bullen-deep*, S S E, and N N W.

C.

Before the Haven of *Caen*, in the Chamber, between *Cripple-ſand* and the *Creyl*, and at *Culbot*, S *b* E, and N *b* W.

At *Caldy*, and in the Bay of *Caernarvon*, E *b* N, and W *b* S.

Without *Calais*, at *Corpus Chriſti-Point*, before and at *Camfer*, N N E, and S S W.

Between *Calais* and *Dover*, before *Conquet*, and at the *N. Cape*, N E, and S W.

At the *Caſkets*, and at *Chamberneſs*, S E *b* S, and N W *b* N.

Between *Guernſey* and the *Caſkets*, before *Cromer*, before the *Caſkets* at *Guernſey*, at *Seven Clifts*, and at *Catneſs*, S E, and N W.

In the Chamber of *Rye*, N *b* E, and S *b* W.

Without the *Caſkets* in the Channel, S E *b* E, and N W *b* W.

At *Concalo*, E and W.

In *Condado*, N and S.

At *Cork*, *Calais*, *Cape Clear*, and in the *Creek*, E N E, and W S W.

At *Cowes*, in the Foſs of *Caen*, in *Calais Road*, and in *Chamberneſs Road*, S S E, and N N W.

At *Orfordneſs* without the Banks, and between *Orford* and *Orwell-Waves*, S S E, and N N W.

At *Orfordneſs*, within the Sands, S *b* E, and N *b* W.

At *Orkneſs*, N E, and S W.

At *Orkney*, S E, and N W.

P.

At *St. Paul's* in the Haven, E and W.

At the *Pens*, *Porthus*, and *Poictu*, N E, and S W.

In *Plymouth*, and before *St. Paul's*, E *b* N, and W *b* S.

Thwart of *Plymouth*, E S E, and W N W.

Before *Podeſſemeck*, E *b* S, and W *b* N.

At the Race of *Portland*, S E, and N W.

At *Portſmouth*, half Tide, N and S.

Q.

At *Queenborough*, N and S.

S.

In the *Sleve*, between *Uſhant* and *Scilly*, at the *Shooe*, at the *Spitt*, at *Southampton*, and all along the *Swin*, N and S.

Upon the Coaſt of *Spain*, and in *Shetland*, N E, and S W.

At *Scilly*, in the *Sound*, *Scarburgh*, and at *Staples*, N E *b* E, and S W *b* W.

At *Seven Iſles*, without the Haven, in the *Broad Sound*, E N E, and W S W.

At the Mouth of *Severn*, between *Scilly* and the *Lizard*, at the *Spurn* and *Stockton*, E *b* N, and W *b* S.

Without *Scilly*, in the Channel, and *Salcomb*, E and W.

At *Sedmouth*, and at the *Start*, E *b* S, and W *b* N.

Off the *Start* in the Channel, E S E, and W N W.

Within the *Seyn*, and before *Shelberg*; and at *Seven Clifts*, S E, and N W.

At *Shoreham*, S E *b* S, and N W *b* N.

At *Seyn Head*, S S E, and N N W.

T.

Within *Tervere*, N *b* E, and S *b* W.

Before *Tervere*, before the River of *Thames*, and at *Tinmouth*, N N E, and S S W.

Before the *Tres*, and *Tinmouth*, before the Bay of *Tinmouth*, N E, and S W.

At the Clifts of the *Texel*, E N E, and W S W.

In *Torbay*, and before the *Texel*, E and W.

In the Road of the *Texel*, E S E, and W N W.

At *Torgou*, S E *b* S, and N W *b* N.

U.

Before *Urck*, N and S.

At *Uſe*, N E, and S W.

Between *Uſhant*, and the *Main*, N E *b* E, and S W *b* W.

St. Vallery, S S E, and N N W.

W.

At *Winchelſea*, N *b* E, and S *b* W.

At the *Weilings*, and from the Weſt End of the *Wight*, N N E, and S S W.

Before the *Weilings*, N E *b* N, and S W *b* S.

At *Whitby*, N E, and S W.

In the Sea of *Wales*, and *Severn*, E N E, and W S W.

In *Wales*, E *b* N, and W *b* S.

At *Wells*, at *Weymouth*, and at *Waterford*, E and W.

At *Weymouth Key*, E *b* S, and W *b* N.

At the *Neſs*, by *Wieringhen*, at *Winterton*, E S E, and W N W.

Thwart the *Iſle of Wight*, in the Channel, all within the *Iſle of Wight*, between the *Iſle of Wight*, and *Beachy*, by the Shore, S E *b* E, and N W *b* W.

At the Eaſt End of *Wight*, and on *Wierington Flats*, S E, and N W.

Y.

Before *Yarmouth*, N N E, and S S W.

At *Youghall*, E N E, and W S W.

At *Yarmouth*, S E *b* E, and N W *b* W.

In *Yarmouth Road, in Yarmouth Haven*, SSE, and NNW.

Z.

On the Coaſt of *Zealand*, N N E, and S S W.

In the *Ziereck Sea*, N E, and S W.

40. By knowing the Point of the *Compaſs* the *Moon* is on when it is high Water at any Place, we know by *Art.* 38. the Time ſhe takes to move from the *Meridian* to that Point; and ſince we can find by *Art.* 29. the Time of the *Moon*'s coming on the *Meridian* any Day; therefore to find the Time of high Water at any Place, and on any Day, we have this Rule, *viz.* To the Hours and Minutes of the *Moon*'s Southing (found by *Art.* 29.) add the Hours and Minutes anſwering to the Point of Flowing (found from the Table of *Art.* 38.) the Sum is the Time of full Sea required; counting from Noon or Midnight.

Example. Required the Time of high Water at *Briſtol Key*, on the ſeventeenth of *May* 1770.

Firſt, By *Art.* 29. I find the *Moon* comes on the *Meridian* that Day, 24 Minutes paſt 6 in the Morning, then becauſe by the Table in the laſt *Article*, the *Moon* muſt be on the E *b* S, or W *b* N Point of the *Compaſs* before it be high Water at *Briſtol*; and ſince by the Table at *Art.* 38. ſhe takes 6 Hours

45 Minutes in moving from the *Meridian* to either of theſe Points; therefore to the 6 Hours 24 Minutes before found, I add 6 Hours 45 Minutes, and the Sum is 13 Hours 9 Minutes, or 9 Minutes paſt 1 in the Afternoon, the Time of full Sea at *Briſtol*, for the Day propoſed, which is alſo the Time in the Morning, when it is full Sea again, the next Day.

SECT. VI.

Concerning the Log-Line *and* Compaſs.

1. THE Method commonly made uſe of for meaſuring the Ship's Way at Sea, or how far ſhe runs in a given Space of Time, is by the *Log-Line*, and *Half-Minute-Glaſs*.

2. The *Log* is a flat Piece of Wood, in Shape like a *Flounder*, having a Piece of Lead faſtened to it's Bottom, which makes it ſtand or ſwim upright in the Water; to this *Log* is tied or faſtened a long Line, which is called the *Log-Line*; and this is commonly divided into certain Spaces, each of which is, or ought to be, ſuch a proportional Part of a nautical Mile (60 of which make a Degree of a great Circle on the Earth) as half a Minute (the Time allowed for the Experiment) is of an Hour.

3. Theſe Spaces are called *Knots*, becauſe at the End of each of them, there is a Piece of Twine with Knots in it, inreeved between the Strands of the *Line*, which ſhews how many of theſe Spaces or *Knots*, are run out during the half Minute. They commonly commence or begin to be counted, at the Diſtance of about 10 Fathom, or 60 Feet from the *Log*; ſo that the *Log*, when it is hove over Board, may be out of the *Eddy* of the Ship's *Wake* before

they begin to count, and for the more ready Diſcovery of this Point of Commencement, there is commonly faſtened at it a Piece of red Rag.

4. The *Log* being thus prepared, and hove over Board from the *Poop*, and the Line veered out (by the Help of a Reel, that turns eaſily, and about which it is wound) as faſt as the *Log* will carry it away, or rather as the Ship ſails from it, will ſhew, according to the Time of veering, how far the Ship has run in a given Time; and conſequently her Rate of ſailing.

5. A Degree of a *Meridian*, which is a great Circle on the Earth, according to the exacteſt Meaſures, contains about 69.545 *Engliſh* Miles; and each Mile, by the Statute being 5280 Feet, therefore a Degree of a *Meridian* will be about 367200 Feet; whence the $\frac{1}{60}$ of that, *viz.* a Minute, or Nautical Mile, muſt contain 6120 ſtandard Feet; conſequently ſince $\frac{1}{2}$ Minute is the $\frac{1}{120}$ Part of an Hour, and each *Knot* being the ſame Part of a Nautical Mile (by *Art.* 2.) it follows, that each *Knot* will contain the $\frac{1}{120}$ Part of 6120 Feet, *viz.* 51 Feet.

6. Hence it is evident, that whatever Number of *Knots* the Ship runs in half a Minute, the ſame Number of Miles ſhe will run in one Hour; ſuppoſing her to run with the ſame Degree of Velocity during that Time; and therefore it is the general Way to heave the *Log* every Hour, to know her Rate of Sailing; but if the Force or Direction of the Wind vary, and not continue the ſame during the whole Hour, or if there has been more Sail ſet, or any Sail handed, that ſo the Ship has run ſwifter or ſlower in any Part of the Hour, than ſhe did at the Time of heaving the *Log*; then there muſt be an Allowance made accordingly for it, and this muſt be according to the Diſcretion of the Artiſt.

7. Sometimes when the Ship is before the Wind, and there is a great Sea ſetting after her, it will bring home the *Log*, and conſequently the Ship will ſail faſter than is given by the *Log*. In this Caſe it is uſual, if there be a very great Sea, to allow one Mile in ten, and leſs in Proportion, if the Sea be not ſo great. But for the Generality, the Ship's Way is really greater than that given by the *Log*; and therefore in order to have the Reckoning rather before than behind the Ship, (which is the ſafeſt Way) it will be proper to make the Space on the *Log-Line* between *Knot* and *Knot*, to conſiſt of 50 Feet inſtead of 51. Some, upon the Suppoſition that 60 Miles make a Degree on the Meridian, make the Diſtance between *Knot* and *Knot* 42 Feet; when at the ſame Time, by common Experience, they are obliged to leſſen the *Half-Minute-Glaſs* by near 6 Seconds, making it to run only 24 Seconds nearly; which plainly is correcting one Miſtake by another.

8. If the Space between *Knot* and *Knot* on the *Log-Line*, ſhould happen to be too great in Proportion to the *Half-Minute-Glaſs*, *viz.* greater than 50 Feet; then the Diſtance given by the *Log*, will be too ſhort, and if that Space be too ſmall, then the Diſtance run (given by the *Log*) will be too great; therefore to find the true Diſtance run in either Caſe, having meaſured the Diſtance between *Knot* and *Knot*, we have the following Proportion, *viz.*

As the true Diſtance 50 Feet, is to the meaſured Diſtance, ſo are the Miles of Diſtance given by the *Log*, to the true Diſtance in Miles that the Ship has run.

Example 1. Suppoſe a Ship runs at the Rate of $6\frac{1}{4}$ *Knots* in half a Minute, but meaſuring the Space between *Knot* and *Knot*, I find it to be 56 Feet; Required the true Diſtance in Miles.

Making it as 50 *Feet*, is to 56 *Feet*, ſo is 6.25 *Knots* to 7 *Knots*, I find that the true Rate of ſailing is 7 Miles in the Hour.

Example 2. Suppoſe a Ship runs at the Rate of $6\frac{1}{2}$ *Knots* in half a Minute, but meaſuring the Space between *Knot* and *Knot*, I find it to be only 44 Feet: Required the true Rate of ſailing.

Making it as 50 *Feet* is to 44 *Feet*, ſo is 6.5 *Knots*, to 5.72 *Knots*; I find that the true Rate of ſailing is 5.72 Miles in the Hour.

9. Again, ſuppoſing the Diſtance between *Knot* and *Knot* on the *Log-Line* to be exactly 50 Feet, but that the *Glaſs* is not 30 Seconds; then if the *Glaſs* require longer Time to run than 30 Seconds, the Diſtance given will be too great, if eſtimated by allowing 1 Mile for every *Knot* run, in the Time the *Glaſs* runs; and, on the contrary, if the *Glaſs* requires leſs Time to run than 30 Seconds, it will give the Diſtance ſailed too ſmall. Conſequently, to find the true Diſtance in either Caſe, we muſt meaſure the Time the *Glaſs* requires to run out (by the Method in the following Article) and then we ſhall have the following Proportion, *viz.*

As the Number of Seconds the *Glaſs* runs, is to half a Minute, or 30 Seconds, ſo is the Diſtance given by the *Log*, to the true Diſtance.

Example 1. Suppoſe a Ship runs at the Rate of $7\frac{1}{2}$ *Knots* in the Time the *Glaſs* runs, but meaſuring the *Glaſs*, I find it runs 34 Seconds: Required the true Diſtance ſailed.

Making it as 34 Seconds, is to 30 Seconds, ſo is 7.5, to 6.6; I find that the Ship ſails at the Rate of 6.6 Miles an Hour.

Example 2. Suppoſe a Ship runs at the Rate of $6\frac{1}{2}$ *Knots*, but meaſuring the *Glaſs*, I find it runs only 25 Seconds: Required the true Rate of ſailing.

Making it as 25 *Seconds*, is to 30 *Seconds*, ſo is 6.5 *Knots* to 7.8 *Knots*; I find that the true Rate of ſailing 7.8 Miles an Hour.

10. In order to know how many Seconds the *Glaſs* runs, you may try it by a Watch or Clock, that vibrates Seconds; but if neither of theſe be at Hand, then take a Line, and to the one End faſtening a *Plumbet*, hang the other upon a *Nail* or *Peg*, ſo as the Diſtance from the *Peg* to the Center of the *Plumbet* be $39\frac{1}{8}$ Inches: Then this put into Motion will vibrate Seconds, *i. e.* every Time it paſſes the Perpendicular you are to count one Second; conſequently by obſerving the Number of Vibrations that it makes during the Time the *Glaſs* is running, we know how many Seconds the *Glaſs* runs.

11. If there be an Error both in the *Log-Line* and *Half-Minute-Glaſs*, *viz.* if the Diſtance between *Knot* and *Knot* on the *Log-Line*, be either greater or leſs than 50 Feet, and the *Glaſs* runs either more or leſs than 30 Seconds, then the finding of the Ship's true Diſtance may be ſomewhat more complicate, and admit of three Caſes, *viz.*

Caſe 1. If the *Glaſs* runs more than 30 Seconds, and the Diſtance between *Knot* and *Knot* be leſs than 50 Feet, then the Diſtance given by the *Log-Line*, *viz.* by allowing 1 Mile for each *Knot* the Ship ſails while the *Glaſs* is running, will always be greater than the true Diſtance; ſince either of theſe Errors give the Diſtance too great. Conſequently to find the true Rate of ſailing, in this Caſe, we muſt firſt find (by *Art.* 8.) the Diſtance, on the Suppoſition that the *Log-Line* is only wrong, and then with this (by *Art.* 9.) we ſhall find the true Diſtance.

Example. Suppoſe a Ship is found to run at the Rate of 6 *Knots*; but examining the *Glaſs*, I find it runs 35 Seconds, and meaſuring the *Log-Line*, I find the Diſtance between *Knot* and *Knot* to be but 46 Feet: Required the true Diſtance run.

Firſt, By *Art.* 8. we have the following Proportion, *viz.* As 50 *Feet* : 46 *Feet* : : 6 *Knots* : 5.52 *Knots.* Then by *Art.* 9. As 35 *Seconds* : 30 *Seconds* : : 5.52 *Knots* : 4.73 *Knots.* Conſequently the true Rate of ſailing is 4.73 Miles an Hour.

Caſe 2. If the *Glaſs* be leſs than 30 Seconds, and the Space between *Knot* and *Knot* be more than 50 Feet; then the Diſtance given by the *Log*, will always be leſs than the true Diſtance, ſince either of theſe Errors leſſen the true Diſtance.

Example. Suppoſe a Ship is found to run at the Rate of 7 *Knots*, but examining the *Glaſs*, I find it runs only 25 Seconds, and meaſuring the Space between *Knot* and *Knot* on the *Log-Line*, I find it is 54 Feet: Required the true Rate of ſailing.

Firſt, By *Art.* 9. As 25 *Seconds* : 30 *Seconds* : : 7 *Knots* : 8.4 *Knots.* Then by *Art.* 8. As 50 *Feet* : 54 *Feet* : : 8.4 *Knots* : 9.072 *Knots.* Conſequently the true Rate of ſailing is 9.072 Miles an Hour.

Caſe 3. If the *Glaſs* runs more than 30 Seconds, and the Space between *Knot* and *Knot* be greater than 50 Feet, or if the *Glaſs* runs leſs than 30 Seconds, and the Space between *Knot* and *Knot* be leſs than 50 Feet; then ſince in either of theſe two Caſes the Effects of the Errors are contrary, 'tis plain the Diſtance will ſometimes be too great, and ſometimes too little, according as the greater Quantity of the Error lies; as will be evident from the following Examples.

Example 1. Suppoſe a Ship is found to run at the Rate of 9 ½ *Knots* per *Glaſs*, but examining the *Glaſs*, it is found to run 36 Seconds, and by meaſuring the Space between *Knot* and *Knot*, it is found to be 58 Feet: Required the true Rate of ſailing.

Firſt, By *Art.* 8. As 50 *Feet* : 58 *Feet* : : 9.5 *Knots* : 11.02 *Knots*. Then by *Art.* 9. As 38 *Seconds* : 30 *Seconds* : : 11.02 *Knots* : 8.7 *Knots*. Conſequently the Ship's true Rate of ſailing is 8.7 Miles an Hour.

Example 2. Suppoſe a Ship runs at the Rate of 6 *Knots* per *Glaſs*; but examining the *Glaſs*, it is found to run only 20 Seconds, and by meaſuring the *Log-Line*, the Diſtance between *Knot* and *Knot* is found to be but 38 Feet: Required the true Rate of ſailing.

Firſt, By *Art.* 8. As 50 *Feet* : 38 *Feet* : : 6 *Knots* : 4.56 *Knots*. Then by *Art.* 9. As 20 *Seconds* : 30 *Seconds* : : 4.56 *Knots* : 6.84 *Knots*. Conſequently the true Rate of ſailing is 6.84 Miles an Hour.

But if in this Caſe it happens, that the Time the *Glaſs* takes to run, be to the Diſtance between *Knot* and *Knot*, as 30, the Seconds in half a Minute, is to 50, the true Diſtance between *Knot* and *Knot*; then 'tis plain, that whatever Number of Seconds the *Glaſs* conſiſts of, and whatever Number of Feet is contained between *Knot* and *Knot*; yet the Diſtance given by the *Log-Line*, will be the true Diſtance in Miles.

12. Though the Method of meaſuring the Ship's Way by the *Log-Line*, deſcribed in the foregoing Articles, be that which is now commonly made uſe of; yet it is ſubject to ſeveral Errors, and theſe pretty conſiderable. For firſt, the *Half-Minute* or *Quarter-Minute-Glaſſes* (by which, and the *Log*, the Ship's Way is determined) are ſeldom or never true, becauſe dry and wet Weather have a great Influence on them; ſo that at one Time they may run more, and at another Time fewer than 30 Seconds, and 'tis evident that a ſmall Error in the *Glaſs*, will cauſe a ſenſible one in the Ship's Way. Again, the chief Property of the *Log* is to have

it ſwim upright, or perpendicular to the *Horizon*; but this is too often wanting in *Logs*, becauſe few Seamen examine whether it is ſo or not, and generally take it upon Truſt, being ſatisfied, if it weigh a little more at the Stern than the Head; and from this there flows an Error in the Reckoning: For if the *Log* does not ſwim upright, it will not hold Water, nor remain ſteady in the Place where it is heaved, ſince the leaſt Check of the Hand in veering the Line will make it come up ſeveral *Feet*; this repeated will make the Errors become *Fathoms*, and perhaps *Knots*, which how inſignificant ſoever they appear, are Miles and Parts of Miles, and amount to a good deal in a long Voyage. Another Inconvenience attending the *Log-Line* is, it's ſtretching and ſhrinking; for when a new Line is firſt uſed, let it be ever ſo well ſtretched upon the Deck, and meaſured as true as poſſible, yet after wetting it ſhrinks conſiderably; and conſequently to be the better aſſured of the Ship's Way by the *Log-Line*, we ought to meaſure and alter the *Knots* on it every Time before we uſe it; but this is ſeldom done oftener than once a Week, and ſometimes not above once or twice in a whole Voyage; alſo when the Line is meaſured to it's greateſt Degree of ſhrinking, it is generally left there; and when by much Uſe it comes to ſtretch again, it is ſeldom or never mended, though it will ſtretch beyond what it firſt ſhrunk. Theſe and many other Errors, too well known, attending that Method of meaſuring the Ship's Way by the *Log-Line*, plainly anſwers for a great many Errors committed in Reckonings. So it is to be wiſhed, that either this Method was improved or amended, or that ſome other Method, leſs ſubject to Error, was found out. There was a Machine ſome Time ago invented by Mr. *Henry de Saumarez*, of the Iſland of *Guernſey*, for meaſuring the Ship's Way, called the *Marine Surveyor*; which is indeed leſs ſubject to Error than the *Log-Line*, and was found by ſeveral Experiments to anſwer the End much more exactly than the *Log-Line*; a Deſcription of which may be ſeen in the *Philoſophical Tranſactions* of the *Royal Society*, Vol. xxxiii. for the Months of *November* and *December* 1725; and alſo in thoſe for the Months of *March* and *April* 1726; and for *March* and *April* 1729.

13. It was ſaid at *Art.* 21. *Sect.* III. that the Meridian and Prime Vertical of any Place cuts the Horizon in 4 Points, at 90 Degrees Diſtance from one another, *viz.* the *North*, *South*, *Eaſt*, and *Weſt*; that Part of the *Meridian* which extends itſelf from the Place to the *North* Point of the *Horizon*, is called the *North Line*; that which tends to the *South* Point of the *Horizon*, is called the *South Line*; and that Part of the *Prime Vertical* which extends towards the Right-hand of the Obſerver, when his Face is turned to the *North*, is called the *Eaſt Line*; and laſtly, that Part of the *Prime Vertical* which tends towards the Left-hand, is called the *Weſt Line*; the four Points in which theſe Lines meet the *Horizon*, are called the *Cardinal Points*.

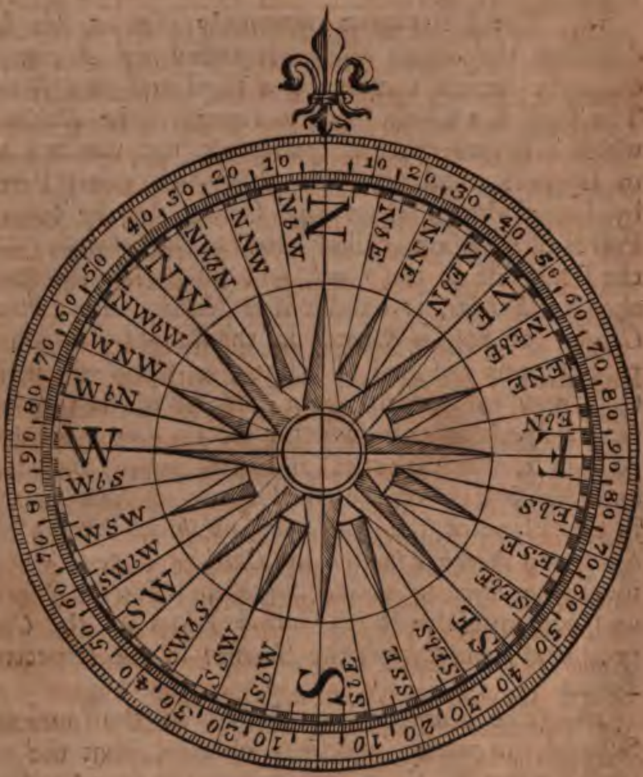
14. In order to determine the *Courſe* of the *Winds*, and to diſcover their various Alterations or Shiftings; each Quadrant of the *Horizon* intercepted between the *Meridian* and *Prime Vertical*, is uſually divided into eight equal Parts, and conſequently the whole *Horizon* into thirty-two; and the Lines drawn from the Place on which the Obſerver ſtandeth, to the Points of Diviſion in his *Horizon*, are called *Rumb Lines*, the four principal of which are thoſe deſcribed in the preceding Article, each of them having it's Name from the Cardinal Point in the *Horizon* towards which it tends; the reſt of the *Rumb Lines* have their Names compouuded of the principal

Lines on each Side of them, as in the following Figure; and over which ſoever of theſe Lines the Courſe of the Wind is directed, that Wind takes it's Name accordingly.

15. The Inſtrument commonly uſed at Sea for directing the Ship's Way, is called the *Mariner*'s *Compaſs*; which conſiſts of a *Card* and two *Boxes.* The *Card* is a Circle made to repreſent the *Horizon*, whoſe Circumference is quartered, and divided into Degrees, and alſo into thirty-two equal Parts, by Lines drawn from the Center to the ſeveral Points of Diviſion, called *Points of the Compaſs.* On the Back-ſide of the *Card*, and juſt below the *South* and *North Line*, is fixed a *Steel Needle*, with a *Braſs Cupola*, or hollow Center in the Middle, which is placed upon the End of a fine *Pin*, upon which the *Card* may eaſily turn about; the *Needle* is touched with a *Load-Stone*, by which a certain Virtue is infuſed into it, that makes it (and conſequently the *South* and *North Line* on the *Card* above it) hang nearly in the Plane of the *Meridian*, by which Means the *South* and *North Lines* on the *Card* produced, would meet the *Horizon* in the *South* and *North Points*; and conſequently all the other Lines on the *Card* produced would meet the *Horizon* in the reſpective Points.

16. The *Card* is repreſented in the annexed Scheme, in which you may obſerve, that the capital Letters N, S, E, W, denote the four Cardinal Points, *viz.* N the *North*, S the *South*, *&c.* and the ſmall Letter *b* ſignifies the Word *by*; the *Rumbs* in the Middle between any two of the Cardinals, are expreſſed by the Letters denoting theſe Cardinals, that which denotes the Point lying in the *Meridian* having the Precedence: Thus the *Rumb* in the Middle between the North and Eaſt is expreſſed N E, which is to be read *North-Eaſt*;

alſo S W denotes the *South-Weſt* Rumb, *&c.* the other Rumbs are expreſſed according to their

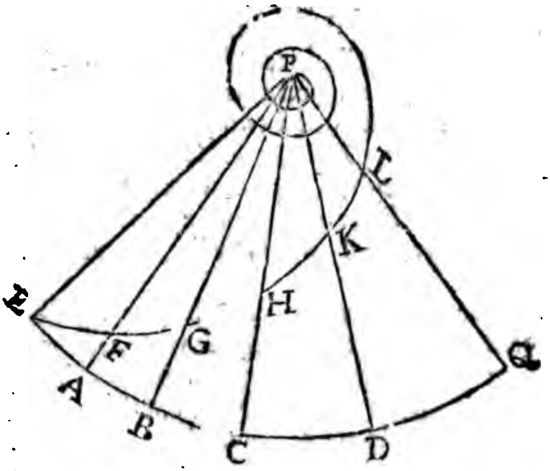


Situation with reſpect to theſe middle Rumbs and the neareſt Cardinals, as is plain from the annexed Scheme.

17. The *Card* is put into a round *Box*, made for it, having a Pin erected in the Middle, upon which the hollow Center of the Needle is fixed, ſo that the *Card* may lie horizontal, and eaſily vibrate according to the Motion of the *Needle*; the *Box* is covered over with a ſmooth Glaſs, and is hung in a Braſs Hoop upon two cylindrical Pins, diametrically oppoſite to one another, and this Hoop is hung within another Braſs Circle, upon two Pins, at right Angles with the former. Theſe two Circles and the *Box* are placed in another ſquare wooden *Box*, ſo that the innermoſt *Box*, and conſequently the *Card*, may keep *horizontal* which Way ſoever the Ship heels.

18. Since the *Meridians* do all meet at the *Poles*, and there form certain Angles with one another; and ſince if we move never ſo little towards the *Eaſt* or *Weſt*, from one Place to another, we thereby change our *Meridian*, and in every Place the *Eaſt* and *Weſt Line* being perpendicular to the *Meridian*; it follows, that the *Eaſt* and *Weſt Line* in the firſt Place will not coincide with the *Eaſt* and *Weſt Line* in the ſecond, but be inclined to it, at a certain Angle; and conſequently all the other *Rumb Lines* at each Place, will be inclined to each other, they always forming the ſame Angles with the *Meridian*. Hence it follows that all *Rumbs*, except the four Cardinals, muſt be *Curves* or *Heliſpherical* Lines, always tending towards the *Pole*, and approaching it by infinite Gyrations or Turnings, but never falling into it. Thus let P be the Pole, E Q an Arch of the Equator, P E, P A, &c. Meridians, and E F G H K L any Rumb; then becauſe the Angles P F E, P E G, &c. are by the Nature of the *Rumb Line* equal, it is evident that it will form a curve Line on the Surface of the Globe, always approaching the *Pole* P, but never

falling into it; for if it were poſſible for it to fall into the *Pole*, then it would follow, that the ſame



Line could cut an infinite Number of other Lines at equal Angles in the ſame Point, which is abſurd.

19. Becauſe there are 32 *Rumbs* (or Points in the *Compaſs*) equally diſtant from one another, therefore the Angle contained between any two of them adjacent, will be 11°, 15′, *viz.* $\frac{1}{32}$ Part of 360°; and ſo the Angle contained between the *Meridian* and the N *b* E, will be 11°, 15′, and between the *Meridian* and the N N E will be 22°, 30′, and ſo of the reſt, as in the following Table.

A Table of the Angles which every ¼ Point of the Compaſs makes with the Meridian.

North.	*South.*	*Points.*	*D.*	*M.*	*North.*	*South.*
		¼	02	49		
		½	05	37		
		¾	08	26		
N*b*E	S*b*E	1	11	15	N*b*W	S*b*W
		1 ¼	14	04		
		1 ½	16	52		
		1 ¾	19	41		
NNE	SSE	2	22	30	NNW	SSW
		2 ¼	25	19		
		2 ½	28	07		
		2 ¾	30	56		
NE*b*N	SE*b*S	3	33	45	NW*b*N	SW*b*S
		3 ¼	36	34		
		3 ½	39	22		
		3 ¾	42	11		
NE	SE	4	45	00	NW	SW
		4 ¼	47	49		
		4 ½	50	37		
		4 ¾	53	26		
NE*b*E	SE*b*E	5	56	15	NW*b*W	SW*b*W
		5 ¼	59	04		
		5 ½	61	52		
		5 ¾	64	42		
ENE	ESE	6	67	30	WNW	WSW
		6 ¼	70	19		
		6 ½	73	07		
		6 ¾	75	56		
E*b*N	E*b*S	7	78	45	W*b*N	W*b*S
		7 ¼	81	34		
		7 ½	84	22		
		7 ¾	87	11		
Eaſt.		8	90	00	*Weſt.*	

SECT. VII.

Of Plane Sailing.

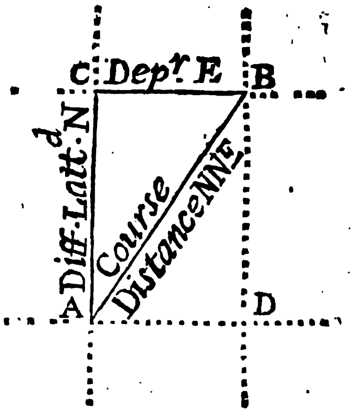
1. THIS Method of ſailing ſuppoſes the Earth to be a *Plane*, and the *Meridians* parallel to one another; and likewiſe the Parallels of Latitude at equal Diſtance from one another, as they really are upon the Globe. Though this Method be in itſelf evidently falſe, yet in a ſhort Run, and eſpecially near the *Equator*, an Account of the Ship's Way may be kept by it tolerably well.

2. The Angle formed by the *Meridian* and Rumb that a Ship ſails upon, is called the Ship's *Courſe.* Thus if a Ship ſails on the N N E Rumb, then her *Courſe* will be 22°, 30′, and ſo of others.

3. The Diſtance between two Places lying on the ſame Parallel counted in Miles of the *Equator*, or the Diſtance of one Place from the *Meridian* of another, counted as above, on the Parallel paſſing over that Place, is called *Meridional Diſtance*; which in *Plane Sailing* goes under the Name of *Departure.*

4. Let A denote a certain Point on the Earth's Surface, A C it's *Meridian*, and A D the Parallel of Latitude paſſing through it; and ſuppoſe a Ship to ſail from A on the N N E Rumb, 'till ſhe arrive at B; and through B draw the Meridian B D (which, according to the Principles of *Plane Sailing*, muſt be parallel to C A) and the Parallel of Latitude B C; then the Length of A B, *viz.* how far the Ship has ſailed upon the N N E Rhumb, is called her *Diſtance*; A C or B D will be her *Difference of Latitude*, or Northing, C B will be her *Departure*, or Eaſting, and the Angle C A B will be the *Courſe.*

Hence it is plain, that the *Diſtance* ſailed, will always be greater than either the *Difference* of *Latitude*, or *Departure*, it being the Hypothenuſe of a right-angled Triangle, whereof the other two are the Legs; except the Ship ſails either on a *Meridian*, or a *Parallel of Latitude*; for if the Ship ſails on a *Meridian*, then it is plain, that her *Diſtance* will be juſt equal to her *Difference of Latitude*, and ſhe will have no *Departure*; but if ſhe ſail on a Parallel, then her *Diſtance* will be the ſame with her *Departure*, and ſhe will have no *Difference of Latitude*. It is evident alſo from the Scheme, that if the *Courſe* be leſs than 4 Points, or 45 Degrees, it's Complement, *viz*. the other *Oblique* Angle, will be greater than 45 Degrees, and ſo the *Difference of Latitude* will be greater than the *Departure*; but if the *Courſe* be greater than 4 Points, then the *Difference of Latitude* will be leſs than the *Departure*; and, laſtly, if the *Courſe* be juſt 4 Points, the *Difference of Latitude* will be equal to the *Departure*.



5. Since the Diſtance, Difference of Latitude, and Departure, form a right-angled Triangle, in

which the *Oblique* Angle oppoſite to the Departure is the Courſe, and the other it's Complement; therefore having any two of theſe given, we can (by *Sect.* 2.) find the reſt; and hence ariſe the Caſes of *Plane Sailing*, which are as follow.

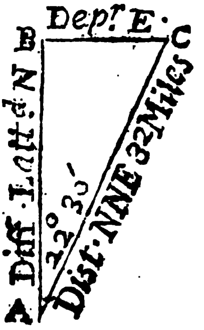
CASE I.

Courſe and Diſtance given, to find Difference of Latitude and Departure.

Example.

Suppoſe a Ship ſails from the Latitude of 30°, 25′ North, N N E 32 Miles. Required the Difference of Latitude and Departure, and the Latitude come to.

The Geometrical Conſtruction of this Caſe, is the ſame as in *Caſe* 3. *of Right-Angled Trigonometry*,



the ſame Things being given in both; and from it we have the following Analogy for finding the Departure, *viz.*

As Radius - - - - - - - - - 10.00000
is to the Diſtance A C 32 - - - - - 1.50515
so

ſo is the Sine of the Courſe A	22°, 30′	9.58284
to the Departure BC - - -	12.35 -	1.08799

ſo the Ship has made 12.25 Miles of Departure Eaſterly, or has got ſo far to the Eaſtward of her Meridian. Then for the Difference of Latitude, or Northing, the Ship has made, we have, by *Caſe 3. of Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance AC - -	32 - -	1.50515
ſo is the Co-ſine of Courſe A	22°, 30′ -	9.96562
to the Difference of Lat. AB	29.57 -	1.47077

ſo the Ship has differed her Latitude, or made of Northing 29.57 Minutes.

And ſince her former Latitude was North, and her Difference of Latitude alſo North. Therefore,

To the Latitude ſailed from -	30°, 25′ N.
add the Difference of Latitude -	00 , 29.57 N.
and the Sum is the Lat. come to	30°, 54.57 N.

By this Caſe is calculated the Table of Difference of Latitude and Departure, to every Degree, Point, and Quarter Point of the Compaſs; for the Diſtance from 1 to 100 Miles, at the End of this Section; the Uſe of which ſhall be there explained.

CASE 2.

Courſe and Difference of Latitude given, to find Diſtance and Departure.

Example.

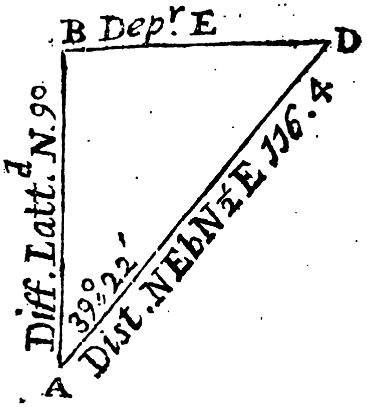
Suppoſe a Ship in the Latitude of 45°, 25′ North, ſails N E *b* N ½ Eaſterly, 'till ſhe come to the Latitude of 46°, 55′ North. Required the Diſtance and Departure made good upon that Courſe.

Since both Latitudes are Northerly, and the Courſe alſo Northerly. Therefore,

From the Latitude come to - -	46°, 55′ N.
ſubtract the Latitude ſailed from -	45 , 25 N.
and there remains - - - - - - -	01 , 30 N.

the Difference of Latitude, equal to 90 Miles.

The Geometrical Conſtruction of this Caſe, is the ſame with that of *Caſe* 1. *of Rectangular Trigonometry*,



and by it we have the following Analogy, for finding the Departure B D, *viz.*

As Radius - - - - - - - - - - -		10.00000
is to the Diff. of Latitude A B -	90 -	1.95424
ſo is the Tangent of Courſe A -	39°, 22′	9.91404
to the Departure B D - - - -	73.84	1.86828

ſo the Ship has got 73.84 Miles to the Eaſtward of her former Meridian.

Again, for the Diſtance A D, we have by *Caſe* 2. *of Rectangular Trigonometry*, the following Proportion, *viz.*

As Radius - - - - - - - - - - - 10.00000
is to the Secant of the Courſe 39°, 22′ 10.11176
ſo is the Difference of Latitude A B 90 1.95424
to the Diſtance A D - - - - 116.4 - 2.06600

CASE 3.

Difference of Latitude and Diſtance given, to find Courſe and Departure.

Example.

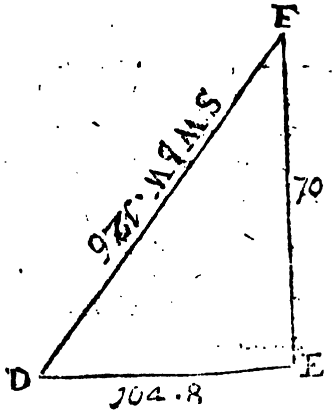
Suppoſe a Ship ſails from the Latitude of 56°, 50′ North, on a Rumb between South and Weſt, 126 Miles, and ſhe is then found by Obſervation to be in the Latitude of 55°, 40′ North; required the Courſe ſhe ſailed on, and her Departure from, the Meridian.

Since the Latitudes are both North, and the Ship ſailing towards the *Equator*; therefore,

From the Latitude ſailed from - - 56°, 50′ N.
ſubtract the obſerved Latitude - - 55 , 40 N.

and the Remainder - - - - - - 01 , 10
equal to 70 Miles, is the Difference of Latitude,

This Caſe is conſtructed the ſame Way as *Caſe* 5, *of Rectangular Trigonometry*, and by it we have the



following Proportion for finding the Angle of the Courſe F, *viz.*

As the Diſtance ſailed D F - 126 - 2.10037
is to Radius - - - - - - - - - 10.00000
ſo is the Diff. of Latitude F E 70 - 1.84510
to the Co-ſine of the Courſe F 56°, 15′ 9.74473

which, becauſe ſhe ſails between South and Weſt, will be South 56°, 15′ Weſt, or S W *b* W. Then for the Departure, we have by *Caſe* 3. *of Rectangular Trigonometry*, the following Proportion, *viz.*

As Radius - - - - - - - - - 10.00000
is to the Diſtance ſailed D F - 126 - 2.10037
ſo is the Sine of the Courſe F - 56°, 15′ 9.91985
to the Departure D E - - 104.8 - 2.02022

conſequently ſhe has made 104.8 Miles of Departure Weſterly.

CASE

CASE 4.

Difference of Latitude and Departure given, to find Courſe and Diſtance.

Example.

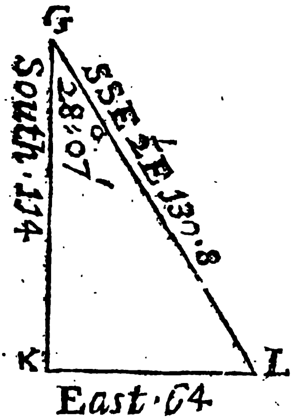
Suppoſe a Ship ſails from the Latitude of 44°, 50′ North, between South and Eaſt, 'till ſhe has made 64 Miles of Eaſting, and is then found by Obſervation to be in the Latitude of 42°, 56′ North. Required the Courſe and Diſtance made good.

Since the Latitudes are both North, and the Ship ſailing towards the *Equator*. Therefore,

From the Latitude ſailed from - 44°, 50′ N.
take the Latitude come to - - 42 , 56 N.

and there remains - - - - - - 01 , 54
equal to 114 Miles, the Difference of Latitude or Southing.

This Caſe is conſtructed the ſame Way as *Caſe* 4. *of Rectangular Trigonometry*, and by it we have the following Proportion to find the Courſe K G L, *viz.*



As the Diff. of Latitude G K 114 - - 2.05690
is to Radius - - - - - - - - - - - 10.00000
ſo is the Departure K L - - 64 - - 1.80618
to the Tangent of Courſe G - 29°, 19′ 9.74928
which becauſe the Ship is ſailing between South and Eaſt, will be South 29°, 19′ Eaſt, or S S E ½ Eaſt nearly.

Then for the Diſtance, we ſhall have by *Caſe* 2, *of Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - - - - 10.00000
is to the Diff. of Latitude G K 114 - - 2.05690
ſo is the Secant of the Courſe 29°, 19′ 10.05952
to the Diſtance G L - - - 130.8 - 2.11642
conſequently the Ship has ſailed on a S S E ½ Eaſt Courſe 130.8 Miles.

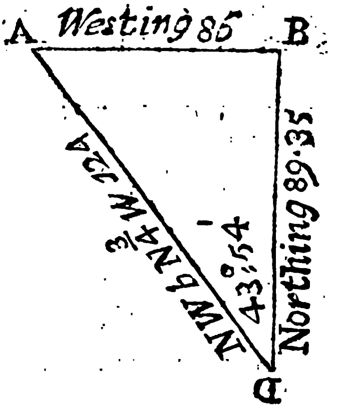
CASE 5.

Diſtance and Departure given, to find Courſe and Difference of Latitude.

Example.

Suppoſe a Ship at Sea, ſails from the Latitude of 34°, 24′ North, between North and Weſt 124 Miles, and is found to have made of Weſting 86 Miles. Required the Courſe ſteered, and the Difference of Latitude or Northing made good.

This Caſe is conſtructed the ſame Way as *Caſe* 5. of *Rectangular Trigonometry*, and by it we have the



following Proportion for finding the Courſe A D B, *viz.*

As the Diſtance A D - -	124 - -	2.09342
is to Radius - - - - - - - - - - -		10.00000
ſo is the Departure A B -	86 - - -	1.93450
to the Sine of the Courſe D	43°, 54′ -	9.84108

ſo the Ship's Courſe is North 43°, 54′ Weſt, or N W *b* N ¼ Weſt nearly.

Then for the Difference of Latitude, we have by *Caſe* 3. of *Rectangular Trigonometry*, the following Analogy, *viz.*

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance A D - -	124 - -	2.09342
ſo is the Co-ſine of the Courſe	43°, 54′ -	9.85766
to the Diff. of Latitude B D -	89.35 -	1.95108

which is equal to 1 Degree, and 29 Minutes nearly.

Hence to find the Latitude the Ship is in, ſince both Latitudes are North, and the Ship ſailing from the Equator. Therefore,

To the Latitude ſailed from - - 34°, 24′ N.
add the Difference of Latitude - - 1°, 29′ N.

the Sum is - - - - - - - - - - 35°, 53′ N.
the Latitude the Ship is in.

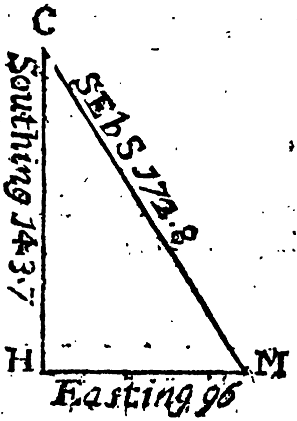
CASE 6.

Courſe and Departure given, to find Diſtance and Difference of Latitude,

Example.

Suppoſe a Ship at Sea, in the Latitude of 24°, 30′ South, ſails S E *b* S, 'till ſhe has made of Eaſting 96 Miles. Required the Diſtance and Difference of Latitude made good on that Courſe.

This Caſe is projected the ſame Way as *Caſe* 1. *of Rectangular Trigonometry*, and by *Caſe* 2. we have



the following Proportion for finding the Diſtance, *viz.*

As the Sine of the Courſe G 33°, 45′ 9.74474
is to the Departure HM - 96 - - 1.98227
ſo is Radius - - - - - - - - - - - 10.00000
to the Diſtance GM - - 172.8 - - 2.23753

Then for the Difference of Latitude, we have by *Caſe* 1. *of Rectangular Trigonometry*, the following Analogy, *viz.*

As the Tangent of the Courſe 33°, 45′ - 9.82489
is to the Departure HM - 96 - - - 1.98227
ſo is Radius - - - - - - - - - - 10.00000
to the Difference of Latitude GH 143.7 2.15738
equal to 2°, 24′ nearly. Conſequently ſince the Latitude the Ship ſailed from was South, and ſhe ſailing ſtill towards the South,

To the Latitude ſailed from - - - 24°, 30′ S.
add the Difference of Latitude - - - 2°, 24′ S.

and the Sum - - - - - - - - - 26°, 54′ S.
is the Latitude ſhe is come to.

6. When a Ship ſtems ſeveral Courſes in 24 Hours, then the reducing all theſe into one, and thereby finding the Courſe and Diſtance made good upon the whole, is commonly called the Reſolving of a *Traverſe.*

7. At Sea they commonly begin each Day's Reckoning from the *Noon* of that Day, and from that Time they ſet down all the different Courſes and Diſtances ſtemmed by the Ship 'till *Noon* next Day, upon the *Log-Board*; then from theſe ſeveral Courſes and Diſtances had from the *Compaſs* and *Log-Line*, they compute the Difference of Latitude and Departure for each Courſe (by *Caſe* 1. *of Plane Sailing*) and theſe, together with the Courſes and Diſtances, are ſet down in a Table called *the Traverſe Table*, which conſiſts of five Columns; in the firſt of which

are placed the Courſes and Diſtances, in the two next the Differences of Latitude belonging to theſe Courſes, according as they are North or South, and in the two laſt are placed the Departures belonging to theſe Courſes, according as they are Eaſt or Weſt. Then they ſum up all the Northings and all the Southings; and taking the Difference of theſe, they know the Difference of Latitude made good by the Ship in the laſt 24 Hours, which will be North or South, according as the Sum of the Northings or Southings is greateſt; the ſame Way, by taking the Sum of all the Eaſtings, and likewiſe of all the Weſtings, and ſubtracting the leſſer of theſe from the greater, the Difference will be the Departure made good by the Ship laſt 24 Hours, which will be Eaſt or Weſt, according as the Sum of the Eaſtings is greater or leſs than the Sum of the Weſtings; then from the Difference of Latitude and Departure made good by the Ship laſt 24 Hours, found as above, they find the true Courſe and Diſtance made good upon the whole (by *Caſe* 4. *of Plane Sailing*), as alſo the Courſe and Diſtance of the intended Port.

Example.

Suppoſe a Ship at Sea, in the Latitude of 48°, 24′ North at *Noon* any Day, is bound to a Port in the Latitude of 43°, 40′ North, whoſe Departure from the Ship is 144 Miles Eaſt; conſequently the direct Courſe and Diſtance of the Ship is S S E ½ Eaſt 315 Miles; but by reaſon of the ſhifting of the Winds ſhe is obliged to ſteer the following Courſes 'till *Noon* next Day, *viz.* S E *b* S 56 Miles, S S E 64 Miles, N W *b* W 48 Miles, S *b* W ½ Weſt 54 Miles, and S E *b* S ½ Eaſt 74 Miles; required the Courſe and Diſtance made good the laſt 24 Hours, and the

Bearing and Diſtance of the Ship from the intended Port.

The Solution of this *Traverſe* depends entirely on the 1ſt and 4th *Caſes* of *Plane Sailing*; and firſt we muſt (by *Caſe* 1.) find the Difference of Latitude and Departure for each Courſe. Thus,

1. Courſe S E *b* S Diſtance 56 Miles.

For Departure.

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance - -	56 - - - -	1.74819
ſo is the Sine of the Courſe	33°, 45′ -	9.74474
to the Departure - - -	31.11 - -	1.49293

For Difference of Latitude.

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance - - -	56 - - -	1.74819
ſo is the Co-ſine of the Courſe	33°, 45′, -	9.91985
to the Diff. of Latitude -	46.57 - -	1.66804

2. Courſe S S E and Diſtance 64 Miles.

For Departure.

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance - - -	64 - - -	1.80618
ſo is the Sine of the Courſe	22°, 30′ -	9.58284
to the Departure - - -	24.5 - -	1.38902

For Difference of Latitude.

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance - - - -	64 - - -	1.80618
ſo is the Co-ſine of the Courſe	22°, 30′ -	9.96562
to the Difference of Latitude	59.13 - -	1.77180

3. Courſe N W *b* W and Diſtance 48 Miles.

For Departure.

As Radius		10.00000
is to the Diſtance	48	1.68124
ſo is the Sine of the Courſe	56°, 15′	9.91985
to the Departure	39.91	1.60109

For Difference of Latitude.

As Radius		10.00000
is to the Diſtance	48	1.68124
ſo is the Co-ſine of the Courſe	56°, 15′	9.74474
to the Difference of Latitude	26.67	1.42598

4. Courſe S *b* W ½ Weſt and Diſtance 54 Miles.

For Departure.

As Radius		10.00000
is to the Diſtance	54	1.73239
ſo is the Sine of the Courſe	16°, 52′	9.46262
to the Departure	15.67	1.19501

For Difference of Latitude.

As Radius		10.00000
is to the Diſtance	54	1.73239
ſo is the Co-ſine of the Courſe	16°, 52′	9.98090
to the Difference of Latitude	51.67	1.71329

5. Courſe S E *b* S ½ Eaſt and Diſtance 74 Miles.

For Departure.

As Radius		10.00000
is to the Diſtance	74	1.86923
ſo is the Sine of the Courſe	39°, 22′	9.80228
to the Departure	46.94	1.67151

For Difference of Latitude.

As Radius - - - - - - - - - - -		10.00000
is to the Diſtance - - - -	74 - -	1.86923
ſo is the Co-Sine of the Courſe	39°, 22′ -	9.88824
to the Difference of Latitude	57.21 -	1.75747

Now theſe ſeveral Courſes and Diſtances, together with the Differences of Latitude and Departures deduced from them, being ſet down in their proper Columns in the *Traverſe Table*, will ſtand as follow,

The Traverſe Table.

Courſes.	*Diſtances.*	*Diff. of Lat.*		*Departure.*	
		N.	*S.*	*E.*	*W.*
S E *b* S - - -	56		46.57	31.11	
S S E - - -	64		59.13	24.5	
N W *b* W - -	48	26.67			39.91
S *b* W ½ Weſt -	54		51:67		15.67
S E *b* S ½ Eaſt -	74		57.21	46.94	
		26.67	214.58	102.55	55.58
			26.67	55.58	
	Diff. of Lat.		187.91	46.97	*Dep.*

Hence it is plain, ſince the Sum of the Northings is 26.67, and of the Southings 214.58, the Difference between theſe, *viz.* 187.91, will be the Southing made good by the Ship the laſt 24 Hours; alſo the Sum of the Eaſtings being 102.55, and of the Weſtings 55.58, the Difference 46.97, will be the Eaſting, or Departure, made good by the Ship's laſt 24 Hours; conſequently to find the true Courſe and Diſtance made good by the Ship in that Time, it will be by *Caſe 4. of Plane Sailing.*

As the Difference of Latitude - 187.91 - 2.27393
is to Radius - - - - - - - - - - 10.00000
ſo is the Departure - - - - - 46.97 - 1.67182
to the Tangent of the Courſe - 14°, 03′ - 9.39789
which is S *b* E ¼ Eaſt nearly. Then for the Diſtance it will be

As Radius - - - - - - - - - - - 10.00000
is to the Difference of Latitude 187.91 - 2.27393
ſo is the Secant of the Courſe 14°, 03′ - 10.01319
to the Diſtance - - - - - 193.7 - 2.28712
conſequently the Ship has made good the laſt 24 Hours, on a S *b* E ¼ Eaſt Courſe, 193.7 Miles; and ſince the Ship is ſailing towards the Equator, therefore

From the Latitude ſailed from - - 48°, 24′ N.
take the Diff. of Latitude made good - 3 , 08 S.

there remains - - - - - - - - 45 , 16 N.
the Latitude the Ship is in North. And becauſe the Port the Ship is bound for lies in the Latitude of 43°, 40′ North, and conſequently South of the Ship, therefore

From the Latitude the Ship is in - 45°, 16′ N.
take the Latitude ſhe is bound for - 43 , 40 N.

and there remains - - - - - - - 1 , 36
or 96 Miles, the Difference of Latitude or Southing the Ship has to make. Again, the whole Eaſting the Ship had to make being 144 Miles, and ſhe having already made 46.97 or 47 Miles of Eaſting; therefore the Departure or Eaſting ſhe ſtill has to make will be 97 Miles. Conſequently to find the direct Courſe and Diſtance between the Ship and the intended Port, it will be by *Caſe* 4. *of Plane Sailing.*

As the Difference of Latitude - 96 - - 1.98227
is to Radius - - - - - - - - - - - 10.00000
ſo is the Departure - - - 97 - - 1.98677
to the Tangent of the Courſe - 45°, 19′ 10.00450

and

As Radius - - - - - - - - - - - 10.00000
is to the Difference of Latitude - 96 - - 1.98227
ſo is the Secant of the Courſe - 45°, 19′ 10.15293
to the Diſtance - - - - - - 136.5 - 2.13520
whence the true Bearing and Diſtance of the intended Port is S E, 136.5 Miles.

8. In the following Table, computed by *Caſe* 1. *of Plane Sailing*, for the more ready working a Traverſe, you may obſerve, that in the Top Column of each Page are placed the Courſes, beginning at 1 Degree, and proceeding through the ſeveral Degrees, Points, and Quarter Points, to 45 Degrees, the Bottom Column beginning with 45°, where the upper ends, and proceeding to 90°, the Degrees in the upper and lower Columns being the Complements of one another. The two Side Columns in each Page contain the Diſtances, *viz.* thoſe on the Left-hand contain the Diſtances from 1 to 50, and thoſe on the Right-hand Page contain the Diſtances from 50 to 130. The other intermediate Columns contain Differences of Latitude and Departures, anſwering to the Courſes in the Top, and Diſtances in the Side Columns. The Uſe of this will be plain from the following Examples.

Example 1.

Suppoſe the Courſe to be S E *b* S ½ Eaſt, and Diſtance 48 Miles; required the Difference of Latitude and Departure.

Firſt, I look in the Top Column for 3½ Points, (becauſe it is leſs than 4 Points, or 45 Degrees) and in the Side Column on the Left-hand Page (becauſe the Diſtance is leſs than 50) for the Diſtance 48; then below the 3½ Points, and on the ſame Line with 48, I find 37.1 for the Difference of Latitude, and 30.4 for the Departure.

Example 2.

Suppoſe the Courſe N E *b* E, and the Diſtance 76 Miles; required the Difference of Latitude and Departure.

Firſt, I look in the Bottom Column for the Courſe, *viz.* 5 Points (becauſe it exceeds 4 Points, or 45 Degrees) and in the Side Column on the Right-hand Page (becauſe the Diſtance exceeds 50) for the Diſtance 76; then above the Courſe, and on the ſame Line with the Diſtance, I find 63.2 for the Departure, and 42.2 for the Difference of Latitude.

If the given Diſtance exceeds the Limits of the Table, *i. e.* be greater than 100, then that Diſtance muſt be divided into two or more Parts, each of which muſt be leſs or equal to 100; then find, as in the preceding Examples, the Difference of Latitude and Departure for each Diſtance on the given Courſe, and the Sum of theſe Differences of Latitudes will be the Difference of Latitude required; alſo the Sum of the Departures will be the Departure required.

Example.

Example 3.

Suppoſe the Courſe S W *b* S, and Diſtance 146 Miles; required the Difference of Latitude and Departure.

Firſt, I divide the given Diſtance into two, *viz.* 100 and 46; then the Differences of Latitude and Departure anſwering to theſe on a S W *b* S Courſe, found in the Table, will be as follows, *viz.*

Courſe.	*Diſt.*	*Diff. of Lat.*	*Depar.*
S W *b* S	100	83.1	55.6
———	46	38.2	25.5
———	146	121.3	81.1

The Sum of the Differences of Latitude, *viz.* 121.3, is the Difference of Latitude required, and the Sum of the Departures, *viz.* 81,1, is the Departure required.

After the ſame Manner may a Traverſe be wrought by the Table, *viz.* by finding the Difference of Latitude and Departure (from the Table) to each Courſe and Diſtance, and ſetting them down in their proper Columns in the Traverſe Table, and then working as in the foregoing Example of a Traverſe.

Example.

Suppoſe a Ship in the Latitude of 36°, 43′ North, ſails on the following Courſes, *viz.* S E *b* S 36 Miles, S S E 43 Miles, S *b* W 64 Miles, and N E *b* N 40 Miles; required the Courſe and Diſtance made good upon the whole; and the Latitude the Ship is come into.

Firſt, I take from the Table the Difference of Latitude and Departure belonging to each Courſe and Diſtance, and theſe ſet down in their proper Columns in the Traverſe Table, will ſtand as follows:

Courſes.	*Diſtances.*	*Diff. of Lat.*		*Departure.*	
		N.	*S.*	*E.*	*W.*
S E *b* S	56	——	46.6	31.1	——
S S E	43	——	39.7	16.5	——
S *b* W	64	——	62.8	——	12.5
N E *b* N	40	33.3	——	22.2	——
		33.3	149.1	69.8	12.5
			33.3	12.5	
		Diff. of Lat.	115.8	57.3	*Dep.*

Whence it is plain, that the Difference of Latitude made good is 115.8 Miles, and the Departure is 57.3 Miles; then for the direct Courſe and Diſtance it will be, by *Caſe* 4. *of Plane Sailing*,

As the Difference of Latitude - 115.8 - 2.06371
is to Radius - - - - - - - - - - 10.00000
ſo is the Departure - - - - 57.3 - 1.75815
to the Tangent of the Courſe - 26°, 20′ 9.69444
which, becauſe the Ship is ſailing between South and Eaſt, will be S S E ½ Eaſt nearly. Again, for the Diſtance it will be,

As Radius - - - - - - - - - - 10.00000
is to the Difference of Latitude - 115.8 - 2.06371
ſo is the Secant of the Courſe - 26°, 20′ - 10.04758
to the Diſtance - - - - 129.2 - 2.11129

And ſince the Ship is ſailing towards the Equator, and conſequently diminiſhing her Latitude, therefore,

From the Latitude ſailed from - -	36°, 43′ N.
ſubtract the Difference of Latitude -	1°, 55′ S.
and there remains - - - - - - -	34°, 48′ N.

the Latitude the Ship is come into.

A Large and very Uſeful

TABLE

OF

Difference of LATITUDE and
DEPARTURE, in Minutes and
Tenth Parts, to every DEGREE and
QUARTER-POINT of the COMPASS,
for the exact working of a *Traverſe*.

Dist.	1 Deg.		2 Deg.		¼ Point.		3 Deg.		4 Deg.		5 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	01.0	00.0	01.0	00.0	01.0	00.0	01.0	00.1	01.0	00.1	01.0	00.1	1
2	02.0	00.0	02.0	00.1	02.0	00.1	02.0	00.1	02.0	00.1	02.0	00.2	2
3	03.0	00.1	03.0	00.1	03.0	00.1	03.0	00.2	03.0	00.2	03.0	00.3	3
4	04.0	00.1	04.0	00.1	04.0	00.2	04.0	00.2	04.0	00.3	04.0	00.3	4
5	05.0	00.1	05.0	00.2	05.0	00.2	05.0	00.3	05.0	00.3	05.0	00.4	5
6	06.0	00.1	06.0	00.2	06.0	00.3	06.0	00.3	06.0	00.4	06.0	00.5	6
7	07.0	00.1	07.0	00.2	07.0	00.3	07.0	00.4	07.0	00.5	07.0	00.6	7
8	08.0	00.1	08.0	00.3	08.0	00.4	08.0	00.4	08.0	00.6	08.0	00.7	8
9	09.0	00.2	09.0	00.3	09.0	00.4	09.0	00.5	09.0	00.6	09.0	00.8	9
10	10.0	00.2	10.0	00.3	10.0	00.5	10.0	00.5	10.0	00.7	10.0	00.9	10
11	11.0	00.2	11.0	00.4	11.0	00.5	11.0	00.6	11.0	00.8	11.0	01.0	11
12	12.0	00.2	12.0	00.4	12.0	00.6	12.0	00.6	12.0	00.8	12.0	01.0	12
13	13.0	00.2	13.0	00.5	13.0	00.6	13.0	00.7	13.0	00.9	12.9	01.1	13
14	14.0	00.2	14.0	00.5	14.0	00.7	14.0	00.7	14.0	01.0	13.9	01.2	14
15	15.0	00.3	15.0	00.5	15.0	00.7	15.0	00.8	15.0	01.0	14.9	01.3	15
16	16.0	00.3	16.0	00.6	16.0	00.8	16.0	00.8	16.0	01.1	15.9	01.4	16
17	17.0	00.3	17.0	00.6	17.0	00.8	17.0	00.9	17.0	01.2	16.9	01.5	17
18	18.0	00.3	18.0	00.6	18.0	00.9	18.0	00.9	17.9	01.3	17.9	01.6	18
19	19.0	00.3	19.0	00.7	19.0	00.9	19.0	01.0	18.9	01.3	18.9	01.7	19
20	20.0	00.4	20.0	00.7	20.0	01.0	20.0	01.0	19.9	01.4	19.9	01.7	20
21	21.0	00.4	21.0	00.7	21.0	01.0	21.0	01.1	20.9	01.5	20.9	01.8	21
22	22.0	00.4	22.0	00.8	22.0	01.1	22.0	01.1	21.9	01.5	21.9	01.9	22
23	23.0	00.4	23.0	00.8	23.0	01.1	23.0	01.2	22.9	01.6	22.9	02.0	23
24	24.0	00.4	24.0	00.8	24.0	01.2	24.0	01.3	23.9	01.7	23.9	02.1	24
25	25.0	00.4	25.0	00.9	25.0	01.2	25.0	01.3	24.9	01.7	24.9	02.2	25
26	26.0	00.5	26.0	00.9	26.0	01.3	26.0	01.4	25.9	01.8	25.9	02.3	26
27	27.0	00.5	27.0	00.9	27.0	01.3	27.0	01.4	26.9	01.9	26.9	02.4	27
28	28.0	00.5	28.0	01.0	28.0	01.4	28.0	01.5	27.9	02.0	27.9	02.4	28
29	29.0	00.5	29.0	01.0	29.0	01.4	29.0	01.5	28.9	02.0	28.9	02.5	29
30	30.0	00.5	30.0	01.1	30.0	01.5	30.0	01.6	29.9	02.1	29.9	02.6	30
31	31.0	00.5	31.0	01.1	30.9	01.5	31.0	01.6	30.9	02.2	30.9	02.7	31
32	32.0	00.6	32.0	01.1	31.9	01.6	31.9	01.7	31.9	02.2	31.9	02.8	32
33	33.0	00.6	33.0	01.2	32.9	01.6	32.9	01.7	32.9	02.3	32.9	02.9	33
34	34.0	00.6	34.0	01.2	33.9	01.7	33.9	01.8	33.9	02.4	33.9	03.0	34
35	35.0	00.6	35.0	01.2	34.9	01.7	34.9	01.8	34.9	02.4	34.9	03.1	35
36	36.0	00.6	36.0	01.3	35.9	01.8	35.9	01.9	35.9	02.5	35.9	03.1	36
37	37.0	00.7	37.0	01.3	36.9	01.8	36.9	01.9	36.9	02.6	36.9	03.2	37
38	38.0	00.7	38.0	01.3	37.9	01.9	37.9	02.0	37.9	02.7	37.9	03.3	38
39	39.0	00.7	39.0	01.4	38.9	01.9	38.9	02.0	38.9	02.7	38.9	03.4	39
40	40.0	00.7	40.0	01.4	39.9	02.0	39.9	02.1	39.9	02.8	39.8	03.5	40
41	41.0	00.7	41.0	01.4	40.9	02.0	40.9	02.1	40.9	02.9	40.8	03.6	41
42	42.0	00.7	42.0	01.5	41.9	02.1	41.9	02.2	41.9	02.9	41.8	03.7	42
43	43.0	00.8	43.0	01.5	42.9	02.1	42.9	02.2	42.9	03.0	42.8	03.8	43
44	44.0	00.8	44.0	01.5	43.9	02.2	43.9	02.3	43.9	03.1	43.8	03.8	44
45	45.0	00.8	45.0	01.6	44.9	02.2	44.9	02.4	44.9	03.1	44.8	03.9	45
46	46.0	00.8	46.0	01.6	45.9	02.2	45.9	02.4	45.9	03.2	45.8	04.0	46
47	47.0	00.8	47.0	01.6	46.9	02.3	46.9	02.5	46.9	03.3	46.8	04.1	47
48	48.0	00.8	48.0	01.7	47.9	02.3	47.9	02.5	47.9	03.4	47.8	04.2	48
49	49.0	00.9	49.0	01.7	48.9	02.4	48.9	02.6	48.9	03.4	48.8	04.3	49
50	50.0	00.9	50.0	01.8	49.9	02.4	49.9	02.6	49.9	03.5	49.8	04.4	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	89 Deg.		88 Deg.		7¾ *Point.*		87 Deg.		86 Deg.		85 Deg.		

Dist.	1 Deg.		2 Deg.		¼ Point.		3 Deg.		4 Deg.		5 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	51.0	00.9	51.0	01.8	50.9	02.5	50.9	02.7	50.9	03.6	50.8	04.4	51
52	52.0	00.9	52.0	01.8	51.9	02.5	51.9	02.7	51.9	03.6	51.8	04.5	52
53	53.0	00.9	53.0	01.9	52.9	02.6	52.9	02.8	52.9	03.7	52.8	04.6	53
54	54.0	00.9	54.0	01.9	53.9	02.6	53.9	02.8	53.9	03.8	53.8	04.7	54
55	55.0	01.0	55.0	01.9	54.9	02.7	54.9	02.9	54.9	03.8	54.8	04.8	55
56	56.0	01.0	56.0	02.0	55.9	02.7	55.9	02.9	55.9	03.9	55.8	04.9	56
57	57.0	01.0	57.0	02.0	56.9	02.8	56.9	03.0	56.8	04.0	56.8	05.0	57
58	58.0	01.0	58.0	02.0	57.9	02.8	57.9	03.0	57.8	04.1	57.8	05.1	58
59	59.0	01.0	59.0	02.1	58.9	02.9	58.9	03.1	58.8	04.1	58.8	05.2	59
60	60.0	01.0	60.0	02.1	59.9	02.9	59.9	03.1	59.8	04.2	59.8	05.2	60
61	61.0	01.1	61.0	02.1	60.9	03.0	60.9	03.2	60.8	04.3	60.8	05.3	61
62	62.0	01.1	62.0	02.2	61.9	03.0	61.9	03.3	61.8	04.3	61.8	05.4	62
63	63.0	01.1	63.0	02.2	62.9	03.1	62.9	03.3	62.8	04.4	62.8	05.5	63
64	64.0	01.1	64.0	02.2	63.9	03.1	63.9	03.4	63.8	04.5	63.8	05.6	64
65	65.0	01.1	65.0	02.3	64.9	03.2	64.9	03.4	64.8	04.5	64.7	05.7	65
66	66.0	01.1	66.0	02.3	65.9	03.2	65.9	03.5	65.8	04.6	65.7	05.8	66
67	67.0	01.2	67.0	02.3	66.9	03.3	66.9	03.5	66.8	04.7	66.7	05.9	67
68	68.0	01.2	67.9	02.4	67.9	03.3	67.9	03.6	67.8	04.8	67.7	05.9	68
69	69.0	01.2	68.9	02.4	68.9	03.4	68.9	03.6	68.8	04.8	68.7	06.0	69
70	70.0	01.2	69.9	02.4	69.9	03.4	69.9	03.7	69.8	04.9	69.7	06.1	70
71	71.0	01.2	70.9	02.5	70.9	03.5	70.9	03.7	70.8	05.0	70.7	06.2	71
72	72.0	01.3	71.9	02.5	71.9	03.5	71.9	03.8	71.8	05.0	71.7	06.3	72
73	73.0	01.3	72.9	02.5	72.9	03.6	72.9	03.8	72.8	05.1	72.7	06.4	73
74	74.0	01.3	73.9	02.6	73.9	03.6	73.9	03.9	73.8	05.2	73.7	06.5	74
75	75.0	01.3	74.9	02.6	74.9	03.7	74.0	03.9	74.8	05.2	74.7	06.6	75
76	76.0	01.3	75.9	02.7	75.9	03.7	75.9	04.0	75.8	05.3	75.7	06.6	76
77	77.0	01.3	76.9	02.7	76.9	03.8	76.9	04.0	76.8	05.4	76.7	06.7	77
78	78.0	01.4	77.9	02.7	77.9	03.8	77.9	04.1	77.8	05.5	77.7	06.8	78
79	79.0	01.4	78.9	02.8	78.9	03.9	78.9	04.1	78.8	05.5	78.7	06.9	79
80	80.0	01.4	79.9	02.8	79.9	03.9	79.9	04.2	79.8	05.6	79.7	07.0	80
81	81.0	01.4	80.9	02.8	80.9	04.0	80.9	04.2	80.8	05.7	80.7	07.1	81
82	82.0	01.4	81.0	02.9	81.9	04.0	81.9	04.3	81.8	05.7	81.7	07.2	82
83	83.0	01.4	82.9	02.9	82.9	04.1	82.9	04.4	82.8	05.8	82.7	07.3	83
84	84.0	01.5	83.9	02.9	83.9	04.1	83.9	04.4	83.8	05.9	83.7	07.3	84
85	85.0	01.5	84.9	03.0	84.9	04.2	84.9	04.5	84.8	05.9	84.7	07.4	85
86	86.0	01.5	85.9	03.0	85.9	04.2	85.9	04.5	85.8	06.0	85.7	07.5	86
87	87.0	01.5	86.9	03.0	86.9	04.3	86.9	04.6	86.8	06.1	86.7	07.6	87
88	88.0	01.5	87.9	03.1	87.9	04.3	87.9	04.6	87.8	06.2	87.7	07.7	88
89	89.0	01.5	88.9	03.1	88.9	04.4	88.9	04.7	88.8	06.2	88.7	07.8	89
90	90.0	01.6	89.9	03.1	89.9	04.4	89.9	04.7	89.8	06.3	89.7	07.9	90
91	91.0	01.6	90.9	03.2	90.9	04.5	90.9	04.8	90.8	06.4	90.7	08.0	91
92	92.0	01.6	91.9	03.2	91.9	04.5	91.9	04.8	91.8	06.4	91.6	08.0	92
93	93.0	01.6	92.9	03.2	92.9	04.6	92.9	04.9	92.8	06.5	92.6	08.1	93
94	94.0	01.6	93.9	03.3	93.9	04.6	93.9	04.9	93.8	06.6	93.6	08.2	94
95	95.0	01.6	94.9	03.3	94.9	04.7	94.9	0.50	94.8	06.6	94.6	08.3	95
96	96.0	01.7	95.9	03.4	95.9	04.7	95.9	05.0	95.8	06.7	95.6	08.4	96
97	97.0	01.7	96.9	03.4	96.9	04.8	96.9	05.1	96.8	07.8	96.6	08.5	97
98	98.0	01.7	97.9	03.4	97.9	04.8	97.9	05.1	97.8	06.9	97.6	08.6	98
99	99.0	01.7	98.9	03.5	98.9	04.9	98.9	05.2	98.8	06.9	98.6	08.7	99
100	100.0	01.7	99.9	03.5	99.9	04.9	99.9	05.2	99.8	07.0	99.6	08.7	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	89 Deg.		88 Deg.		7¾ *Point.*		87 Deg.		86 Deg.		85 Deg.		

Dist.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.1	39
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.4	41
42	[illegible]	[illegible]	[illegible]	[illegible]	41.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.6	42
43	[illegible]	[illegible]	[illegible]	[illegible]	42.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.7	43
44	[illegible]	[illegible]	[illegible]	[illegible]	43.7	05.4	43.6	[illegible]	43.5	[illegible]	[illegible]	06.9	44
45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.6	44.4	07.0	45
46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	06.4	45.5	06.7	45.4	07.2	46
47	[illegible]	[illegible]	46.7	04.9	[illegible]	[illegible]	46.5	06.5	46.5	06.9	46.4	07.3	47
48	[illegible]	[illegible]	47.7	[illegible]	47.6	05.9	47.5	06.7	47.5	07.0	47.4	07.5	48
49	[illegible]	[illegible]	48.7	05.1	48.6	06.0	48.5	06.8	48.5	07.2	48.4	07.7	49
50	49.[illegible]	[illegible]	49.7	05.2	49.6	06.1	49.5	07.0	49.5	07.3	49.4	07.8	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	7½ Point.		84 Deg.		83 Deg.		82 Deg.		7¼ Point.		81 Deg.		

Dist.	½ Point.		6 Deg.		7 Deg.		8 Deg.		¾ Point.		9 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.7	05.0	50.7	05.3	50.6	06.2	50.5	07.1	50.4	07.5	50.4	08.0	51
52	51.7	05.1	51.7	05.4	51.6	06.3	51.5	07.2	51.4	07.6	51.4	08.1	52
53	52.7	05.2	52.7	05.5	52.6	06.4	52.5	07.4	52.4	07.8	52.3	08.3	53
54	53.7	05.3	53.7	05.6	53.6	06.6	53.5	07.5	53.4	07.9	53.3	08.4	54
55	54.7	05.4	54.7	05.7	54.6	06.7	54.5	07.6	54.4	08.1	54.3	08.6	55
56	55.7	05.5	55.7	05.8	55.6	06.8	55.5	07.8	55.4	08.2	55.3	08.7	56
57	56.7	05.6	56.7	06.0	56.6	06.9	56.4	07.9	56.4	08.4	56.3	08.9	57
58	57.7	05.7	57.7	06.1	57.6	07.1	57.4	08.1	57.4	08.5	57.3	09.1	58
59	58.7	05.8	58.7	06.2	58.6	07.2	58.4	08.2	58.4	08.7	58.3	09.2	59
60	59.7	05.9	59.7	06.3	59.5	07.3	59.4	08.3	59.4	08.8	59.3	09.4	60
61	60.7	06.0	60.7	06.4	60.5	07.4	60.4	08.5	60.3	08.9	60.2	09.5	61
62	61.7	06.1	61.6	06.5	61.5	07.6	61.4	08.6	61.3	09.1	61.2	09.7	62
63	62.7	06.2	62.6	06.6	62.5	07.7	62.4	08.8	62.3	09.2	62.2	09.9	63
64	63.7	06.3	63.6	06.7	63.5	07.8	63.4	08.9	63.3	09.4	63.2	10.0	64
65	64.7	06.4	64.6	06.8	64.5	07.9	64.4	09.1	64.3	09.5	64.2	10.2	65
66	65.7	06.5	65.6	06.9	65.5	08.0	65.4	09.2	65.3	09.7	65.2	10.3	66
67	66.7	06.6	66.6	07.0	66.5	08.2	66.3	09.3	66.3	09.8	66.2	10.5	67
68	67.7	06.7	67.6	07.1	67.5	08.3	67.3	09.5	67.3	10.0	67.2	10.6	68
69	68.7	06.8	68.6	07.2	68.5	08.4	68.3	09.6	68.2	10.1	68.1	10.8	69
70	69.7	06.9	69.6	07.3	69.5	08.5	69.3	09.7	69.2	10.3	69.1	10.9	70
71	70.6	07.0	70.6	07.4	70.5	08.7	70.3	09.9	70.2	10.4	70.1	11.1	71
72	71.6	07.1	71.6	07.5	71.5	08.8	71.3	10.0	71.2	10.6	71.1	11.3	72
73	72.6	07.1	72.6	07.6	72.4	08.9	72.3	10.2	72.2	10.7	72.1	11.4	73
74	73.6	07.2	73.6	07.7	73.4	09.0	73.3	10.3	73.2	10.9	73.1	11.6	74
75	74.6	07.3	74.6	07.8	74.4	09.1	74.3	10.4	74.2	11.0	74.1	11.7	75
76	75.6	07.4	75.6	07.9	75.4	09.3	75.3	10.6	75.2	11.1	75.1	11.9	76
77	76.6	07.5	76.6	08.0	76.4	09.4	76.2	10.7	76.2	11.3	76.0	12.0	77
78	77.6	07.6	77.6	08.1	77.4	09.5	77.2	10.9	77.1	11.4	77.0	12.2	78
79	78.6	07.7	78.6	08.3	78.4	09.6	78.2	11.0	78.1	11.6	78.0	12.4	79
80	79.6	07.8	79.6	08.4	79.4	09.8	79.2	11.1	79.1	11.7	79.0	12.5	80
81	80.6	07.9	80.5	08.5	80.4	09.9	80.2	11.3	80.1	11.9	80.0	12.7	81
82	81.6	08.0	81.5	08.6	81.4	10.0	81.2	11.4	81.1	12.0	81.0	12.	82
83	82.6	08.1	82.5	08.7	82.4	10.1	82.2	11.5	82.1	12.2	82.0	13.0	83
84	83.6	08.2	83.5	08.8	83.4	10.2	83.2	11.7	83.1	12.3	83.0	13.1	84
85	84.6	08.3	84.5	08.9	84.4	10.3	84.2	11.8	84.1	12.5	83.9	13.3	85
86	85.6	08.4	85.5	09.0	85.4	10.4	85.2	12.0	85.1	12.6	84.9	13.4	86
87	86.6	08.5	86.5	09.1	86.3	10.5	86.1	12.1	86.0	12.8	85.9	13.6	87
88	87.6	08.6	87.5	09.2	87.3	10.7	87.1	12.2	87.0	12.9	86.9	13.8	88
89	88.6	08.7	88.5	09.3	88.3	10.9	88.1	12.4	88.0	13.1	87.9	13.9	89
90	89.6	08.8	89.5	09.4	89.3	11.0	89.1	12.5	89.0	13.2	88.9	14.1	90
91	90.6	08.9	90.5	09.5	90.3	11.1	90.1	12.7	90.0	13.4	89.9	14.2	91
92	91.6	09.0	91.5	09.6	91.3	11.2	91.1	12.8	91.0	13.5	90.9	14.4	92
93	92.6	09.1	92.5	09.7	92.3	11.3	92.1	12.9	92.0	13.6	91.8	14.5	93
94	93.5	09.2	93.5	09.8	93.3	11.5	93.1	13.1	93.0	13.8	92.8	14.7	94
95	94.5	09.3	94.5	09.9	94.3	11.6	94.1	13.2	94.0	13.9	93.8	14.9	95
96	95.5	09.4	95.5	10.0	95.3	11.7	95.1	13.4	95.0	14.1	94.8	15.0	96
97	96.5	09.5	96.5	10.1	96.3	11.8	96.0	13.5	95.9	14.2	95.8	15.2	97
98	97.5	09.6	97.5	10.2	97.3	12.0	97.0	13.6	96.9	14.4	96.8	15.3	98
96	98.5	09.7	98.5	10.3	98.3	12.1	98.0	13.8	97.9	14.5	97.8	15.5	99
100	99.5	09.8	99.4	10.4	99.3	12.2	99.0	13.9	98.9	14.7	98.8	15.6	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	7½ Point.		84 Deg.		83 Deg.		82 Deg.		7¼ Point.		81 Deg.		

Dist.	10 Deg.		11 Deg.		1 Point.		12 Deg.		13 Deg.		14 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	01.0	00.2	01.0	00.2	01.0	00.2	01.0	00.2	01.0	00.2	01.0	00.2	1
2	02.0	00.3	02.0	00.4	02.0	00.4	02.0	00.4	01.9	00.4	01.9	00.5	2
3	02.9	00.5	02.9	00.6	02.9	00.6	02.9	00.6	02.9	00.7	02.9	00.7	3
4	03.9	00.7	03.9	00.8	03.9	00.8	03.9	00.8	03.9	00.9	03.9	01.0	4
5	04.9	00.6	04.9	00.9	04.9	01.0	04.9	01.0	04.9	01.1	04.8	01.2	5
6	05.9	01.0	05.9	01.1	05.9	01.2	05.9	01.2	05.8	01.3	05.8	01.4	6
7	06.9	01.2	06.9	01.3	06.9	01.4	06.8	01.5	06.8	01.6	06.8	01.7	7
8	07.9	01.4	07.8	01.5	07.8	01.6	07.8	01.7	07.8	01.8	07.8	01.9	8
9	08.9	01.6	08.8	01.7	08.8	01.8	08.8	01.9	08.8	02.0	08.7	02.2	9
10	09.8	01.7	09.8	01.9	09.8	01.9	09.8	02.1	09.7	02.2	09.7	02.4	10
11	10.8	01.9	10.8	02.1	10.8	02.1	10.8	02.3	10.7	02.5	10.7	02.7	11
12	11.8	02.1	11.8	02.3	11.8	02.3	11.7	02.5	11.7	02.7	11.6	02.9	12
13	12.8	02.3	12.8	02.5	12.7	02.5	12.7	02.7	12.7	02.9	12.6	03.1	13
14	13.8	02.4	13.7	02.7	13.7	02.7	13.7	02.9	13.6	03.1	13.6	03.3	14
15	14.8	02.6	14.7	02.9	14.7	02.9	14.7	03.1	14.6	03.4	14.5	03.6	15
16	15.7	02.8	15.7	03.0	15.7	03.1	15.6	03.3	15.6	03.6	15.5	03.9	16
17	16.7	02.9	16.7	03.2	16.7	03.3	16.6	03.5	16.6	03.8	16.5	04.1	17
18	17.7	03.1	17.7	03.4	17.7	03.6	17.6	03.7	17.5	04.0	17.5	04.4	18
19	18.7	03.3	18.6	03.6	18.6	03.7	18.6	03.9	18.5	04.3	18.4	04.6	19
20	19.7	03.5	19.6	03.8	19.6	03.9	19.6	04.2	19.5	04.5	19.4	04.8	20
21	20.7	03.6	20.6	04.0	20.6	04.1	20.5	04.4	20.5	04.7	20.4	05.1	21
22	21.7	03.8	21.6	04.2	21.6	04.3	21.5	04.6	21.4	04.9	21.3	05.3	22
23	22.6	04.0	22.6	04.4	22.6	04.5	22.5	04.8	22.4	05.2	22.3	05.6	23
24	23.6	04.2	23.6	04.6	23.5	04.7	23.5	05.0	23.4	05.4	23.3	05.8	24
25	24.6	04.3	24.5	04.8	24.5	04.9	24.4	05.2	24.3	05.6	24.3	06.0	25
26	25.6	04.5	25.5	05.0	25.5	05.1	25.4	05.4	25.3	05.8	25.2	06.3	26
27	26.6	04.7	26.5	05.1	26.5	05.3	26.4	05.6	26.3	06.1	26.2	06.5	27
28	27.6	04.9	27.5	05.3	27.5	05.5	27.4	05.8	27.3	06.3	27.2	06.8	28
29	28.6	05.0	28.5	05.5	28.4	05.7	28.4	06.0	28.2	06.5	28.1	07.0	29
30	29.5	05.2	29.4	05.7	29.4	05.9	29.3	06.2	29.2	06.7	29.1	07.3	30
31	30.5	05.4	30.4	05.9	30.4	06.0	30.3	06.4	30.2	07.0	30.1	07.5	31
32	31.5	05.5	31.4	06.1	31.4	06.2	31.3	06.6	31.2	07.2	31.0	07.7	32
33	32.5	05.7	32.4	06.3	32.4	06.5	32.3	06.9	32.1	07.4	32.0	08.0	33
34	33.5	05.9	33.4	06.5	33.3	06.6	33.2	07.1	33.1	07.6	33.0	08.2	34
35	34.5	06.1	34.4	06.7	34.3	06.8	34.2	07.3	34.1	07.9	34.0	08.5	35
36	35.4	06.2	35.3	06.9	35.3	07.0	35.2	07.5	35.1	08.1	34.9	08.7	36
37	36.4	06.4	36.3	07.1	36.3	07.2	36.2	07.7	36.0	08.3	35.9	09.0	37
38	37.4	06.6	37.3	07.2	37.3	07.4	37.2	07.9	37.0	08.5	36.9	09.2	38
39	38.4	06.8	38.3	07.4	38.2	07.6	38.1	08.1	38.0	08.8	37.8	09.4	39
40	39.4	06.9	39.3	07.6	39.2	07.8	39.1	08.3	39.0	09.0	38.8	09.7	40
41	40.4	07.1	40.2	07.8	40.2	08.0	40.1	08.5	39.9	09.2	39.8	09.9	41
42	41.4	07.3	41.2	08.0	41.2	08.2	41.1	08.7	40.9	09.4	40.7	10.2	42
43	42.3	07.5	42.2	08.2	42.2	08.4	42.1	08.9	41.9	09.7	41.7	10.4	43
44	43.3	07.7	43.2	08.4	43.1	08.6	43.0	09.1	42.9	09.9	42.7	10.6	44
45	44.3	07.8	44.2	08.6	44.1	08.8	44.0	09.4	43.8	10.1	43.7	10.8	45
46	45.3	08.0	45.2	08.8	45.1	09.0	45.0	09.6	44.8	10.3	44.6	11.1	46
47	46.3	08.1	46.1	09.0	46.1	09.2	46.0	09.8	45.8	10.6	45.6	11.4	47
48	47.3	08.3	47.1	09.2	47.1	09.4	47.0	10.0	46.8	10.8	46.6	11.6	48
49	48.3	08.5	48.1	09.3	48.1	09.5	47.9	10.2	47.7	11.0	47.5	11.9	49
50	49.2	08.7	49.1	09.5	49.0	09.8	48.9	10.4	48.7	11.2	48.5	12.1	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	80 Deg.		79 Deg.		7 Points.		78 Deg.		77 Deg.		76 Deg.		

Dist.	10 Deg.		11 Deg.		1 Point.		12 Deg.		13 Deg.		14 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	50.2	08.8	50.0	09.7	50.0	10.0	49.9	10.6	49.7	11.5	49.5	12.3	51
52	51.2	09.0	51.0	09.9	51.0	10.1	50.9	10.8	50.7	11.7	50.5	12.6	52
53	52.2	09.2	52.0	10.1	52.0	10.3	51.8	11.0	51.6	11.9	51.4	12.8	53
54	53.2	09.4	53.0	10.3	53.0	10.5	52.8	11.2	52.6	12.1	52.4	13.1	54
55	54.2	09.5	54.0	10.5	53.9	10.7	53.8	11.4	53.6	12.4	53.4	13.3	55
56	55.1	09.7	55.0	10.7	54.9	10.9	54.8	11.6	54.5	12.6	54.3	13.5	56
57	56.1	09.9	56.0	10.8	55.9	11.1	55.8	11.8	55.5	12.8	55.3	13.8	57
58	57.1	10.1	56.9	11.1	56.9	11.3	56.7	12.1	56.5	13.0	56.3	14.0	58
59	58.1	10.2	57.9	11.3	57.9	11.5	57.7	12.3	57.5	13.3	57.2	14.3	59
60	59.1	10.4	58.9	11.4	58.8	11.7	58.7	12.5	58.5	13.5	58.2	14.5	60
61	60.1	10.6	59.9	11.6	59.8	11.9	59.7	12.7	59.4	13.7	59.2	14.8	61
62	61.1	10.8	60.9	11.8	60.8	12.1	60.6	12.9	60.4	13.9	60.2	15.0	62
63	62.0	10.9	61.8	12.0	61.8	12.3	61.6	13.1	61.4	14.2	61.1	15.2	63
64	63.0	11.1	62.8	12.2	62.8	12.5	62.6	13.3	62.4	14.4	62.1	15.5	64
65	64.0	11.3	63.8	12.4	63.7	12.7	63.6	13.5	63.3	14.6	63.1	15.7	65
66	65.0	11.5	64.8	12.6	64.7	12.9	64.6	13.7	64.3	14.8	64.0	16.0	66
67	66.0	11.6	65.8	12.8	65.7	13.1	65.5	13.9	65.3	15.1	65.0	16.2	67
68	67.0	11.8	66.7	13.0	66.7	13.3	66.5	14.1	66.2	15.3	66.0	16.4	68
69	68.0	12.0	67.7	13.2	67.7	13.5	67.5	14.3	67.2	15.5	66.9	16.7	69
70	68.9	12.2	68.7	13.4	68.7	13.7	68.5	14.5	68.2	15.7	67.9	16.9	70
71	69.9	12.3	69.7	13.5	69.6	13.9	69.4	14.8	69.2	16.0	68.9	17.2	71
72	70.9	12.5	70.7	13.7	70.6	14.0	70.4	15.0	70.1	16.2	69.9	17.4	72
73	71.9	12.7	71.7	13.9	71.6	14.2	71.4	15.2	71.1	16.4	70.8	17.6	73
74	72.9	12.8	72.6	14.1	72.6	14.4	72.4	15.4	72.1	16.6	71.8	17.9	74
75	73.9	13.0	73.6	14.3	73.6	14.6	73.4	15.6	73.1	16.9	72.8	18.1	75
76	74.8	13.2	74.6	14.5	74.5	14.8	74.3	15.8	74.0	17.1	73.7	18.4	76
77	75.8	13.4	75.6	14.7	75.5	15.0	75.3	16.0	75.0	17.3	74.7	18.6	77
78	76.8	13.5	76.6	14.9	76.5	15.2	76.3	16.2	76.0	17.5	75.7	18.9	78
79	77.8	13.7	77.5	15.1	77.5	15.4	77.3	16.4	77.0	17.8	76.6	19.1	79
80	78.8	13.9	78.5	15.3	78.5	15.6	78.2	16.6	77.9	18.0	77.6	19.3	80
81	79.8	14.1	79.5	15.5	79.4	15.8	79.2	16.8	78.9	18.2	78.6	19.4	81
82	80.8	14.2	80.5	15.6	80.4	16.0	80.2	17.0	79.9	18.4	79.6	19.8	82
83	81.7	14.4	81.5	15.8	81.4	16.2	81.2	17.2	80.9	18.7	80.5	20.1	83
84	82.7	14.6	82.5	16.0	82.4	16.4	82.2	17.5	81.8	18.9	81.5	20.3	84
85	83.7	14.8	83.4	16.2	83.4	16.6	83.1	17.7	82.8	19.1	82.5	20.6	85
86	84.7	14.9	84.4	16.4	84.3	16.8	84.1	17.9	83.8	19.3	83.4	20.8	86
87	85.7	15.1	85.4	16.6	85.3	17.0	85.1	18.1	84.8	19.6	84.4	21.0	87
88	86.7	15.3	86.4	16.8	86.3	17.2	86.1	18.3	85.7	19.8	85.4	21.3	88
89	87.6	15.4	87.4	17.0	87.3	17.4	87.1	18.5	86.7	20.0	86.4	21.5	89
90	88.6	15.6	88.3	17.2	88.3	17.6	88.0	18.7	87.7	20.2	87.3	21.8	90
91	89.6	15.8	89.3	17.4	89.2	17.8	89.0	18.9	88.7	20.5	88.3	22.0	91
92	90.6	16.0	90.3	17.6	90.2	17.9	90.0	19.1	89.6	20.7	89.3	22.2	92
93	91.6	16.1	91.3	17.7	91.2	18.1	91.0	19.3	90.6	20.9	90.2	22.5	93
94	92.6	16.3	92.3	17.9	92.2	18.3	91.9	19.5	91.6	21.1	91.2	22.7	94
95	93.5	16.5	93.3	18.1	93.2	18.5	[illegible]	10.7	92.6	21.4	92.2	23.0	95
96	94.5	16.7	94.2	18.3	94.2	18.7	93.9	20.0	93.5	21.6	93.1	23.2	96
97	95.5	16.8	95.2	18.5	95.1	18.9	94.9	20.2	94.5	21.8	94.1	23.5	97
98	96.5	17.0	96.2	18.7	96.1	19.1	95.9	20.4	95.5	22.0	95.1	23.7	98
99	97.5	17.2	97.2	18.9	97.1	19.3	96.8	20.6	96.5	22.3	96.1	23.9	99
100	98.5	17.4	98.2	19.1	98.1	19.5	97.8	20.8	97.4	22.5	97.0	14.2	100
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	
Dist.	80 Deg.		79 Deg.		7 Points.		78 Deg.		77 Deg.		76 Deg.		Dist.

A TABLE of Difference

Dist.	1¼ *Point.*		15 Deg.		16 Deg.		1½ *Point.*		17 Deg.		18 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	01.0	00.2	01.0	00.3	01.0	00.3	01.0	00.3	01.0	00.3	00.9	00.3	1
2	01.9	00.5	01.9	00.5	01.9	00.5	01.9	00.6	01.9	00.6	01.9	00.6	2
3	02.9	00.7	02.9	00.8	02.9	00.8	02.9	00.9	02.9	00.9	02.8	00.9	3
4	03.9	01.0	03.9	01.0	03.8	01.1	03.8	01.2	03.8	01.2	03.8	01.2	4
5	04.9	01.2	04.8	01.3	04.8	01.4	04.8	01.5	04.8	01.5	04.8	01.5	5
6	05.8	01.5	05.8	01.5	05.8	01.6	05.8	01.7	05.7	01.7	05.7	01.8	6
7	06.8	01.7	06.8	01.8	06.8	01.9	06.8	02.0	06.7	02.0	06.7	02.2	7
8	07.8	01.9	07.8	02.1	07.7	02.2	07.7	02.3	07.6	02.3	07.6	02.5	8
9	08.7	02.2	08.7	02.3	08.6	02.5	08.6	02.6	08.6	02.6	08.6	02.8	9
10	09.7	02.4	09.7	02.6	09.6	02.8	09.6	02.9	09.6	02.9	09.5	03.1	10
11	10.7	02.8	10.6	02.8	10.6	03.0	10.5	03.2	10.5	03.2	10.5	03.4	11
12	11.6	02.9	11.6	03.1	11.5	03.3	11.5	03.5	11.5	03.5	11.4	03.7	12
13	12.6	03.2	12.6	03.4	12.5	03.6	12.4	03.8	12.4	03.8	12.4	04.0	13
14	13.6	03.4	13.5	03.6	13.5	03.9	13.4	04.1	13.4	04.1	13.3	04.3	14
15	14.5	03.6	14.5	03.9	14.4	04.1	14.4	04.4	14.3	04.4	14.3	04.6	15
16	15.5	04.0	15.5	04.1	15.4	04.4	15.3	04.6	15.3	04.7	15.2	04.9	16
17	16.5	04.1	16.4	04.4	16.3	04.7	16.3	04.9	16.3	05.0	16.2	05.2	17
18	17.5	04.4	17.4	04.7	17.3	05.0	17.2	05.2	17.2	05.3	17.1	05.6	18
19	18.4	04.6	18.4	04.9	18.3	05.2	18.2	05.5	18.2	05.5	18.1	05.9	19
20	19.4	04.9	19.3	05.2	19.2	05.5	19.1	05.8	19.1	05.8	19.0	06.2	20
21	20.4	05.1	20.3	05.4	20.2	05.8	20.1	06.1	20.1	06.1	20.0	06.5	21
22	21.3	05.3	21.2	05.7	21.1	06.1	21.0	06.4	21.0	06.4	20.9	06.8	22
23	22.3	05.6	22.2	06.0	22.1	06.3	22.0	06.7	22.0	06.7	21.9	07.1	23
24	23.3	05.8	23.2	06.2	23.1	06.6	23.0	07.0	22.9	07.0	22.8	07.4	24
25	24.2	06.1	24.1	06.5	24.0	06.9	23.9	07.3	23.9	07.3	23.8	07.7	25
26	25.2	06.3	25.1	06.7	24.9	07.2	24.9	07.5	24.9	07.6	24.7	08.0	26
27	26.2	06.6	26.0	07.0	25.9	07.4	25.8	07.8	25.8	07.9	25.7	08.3	27
28	27.2	06.8	27.0	07.2	26.9	07.7	26.8	08.1	26.8	08.2	26.6	08.6	28
29	28.1	07.0	28.0	07.5	27.8	08.0	27.8	08.4	27.7	08.5	27.6	09.0	29
30	29.1	07.3	29.0	07.8	28.8	08.3	28.7	08.7	28.7	08.8	28.5	09.3	30
31	30.1	07.5	29.9	08.0	29.8	08.5	29.7	09.0	29.6	09.1	29.5	09.6	31
32	31.0	07.9	30.9	08.3	30.7	08.8	30.6	09.3	30.6	09.3	30.4	10.0	32
33	32.0	08.0	31.9	08.5	31.7	09.1	31.6	09.6	31.6	09.6	31.4	10.2	33
34	33.0	08.3	32.8	08.8	32.7	09.4	32.5	09.9	32.5	09.9	32.3	10.5	34
35	33.9	08.5	33.8	09.0	33.6	09.6	33.5	10.2	33.5	10.2	33.3	10.8	35
36	34.9	08.7	34.8	09.3	34.6	09.9	34.4	10.4	34.4	10.5	34.2	11.1	36
37	35.9	09.0	35.7	09.6	35.6	10.2	35.4	10.7	35.4	10.8	35.2	11.4	37
38	36.9	09.2	36.7	09.8	36.5	10.5	36.4	11.0	36.3	11.1	36.1	11.7	38
39	37.8	09.5	37.7	10.1	37.5	10.7	37.3	11.3	37.3	11.4	37.1	12.0	39
40	38.8	09.7	38.6	10.3	38.4	11.0	38.3	11.6	38.2	11.7	38.0	12.4	40
41	39.8	10.0	39.6	10.6	39.4	11.3	39.2	11.9	39.2	12.0	39.0	12.7	41
42	40.7	10.2	40.6	10.9	40.4	11.6	40.2	12.2	40.2	12.3	39.9	13.0	42
43	41.7	10.4	41.5	11.1	41.3	11.8	41.1	12.5	41.1	12.6	40.9	13.3	43
44	42.7	10.7	42.5	11.4	42.3	12.1	42.1	12.8	42.1	12.9	41.8	13.6	44
45	43.6	10.9	43.5	11.6	43.3	12.4	43.1	13.1	43.0	13.2	42.8	13.9	45
46	44.6	11.2	44.4	11.9	44.2	12.7	44.0	13.4	44.0	13.4	43.7	14.2	46
47	45.6	11.4	45.4	12.2	45.2	12.9	45.0	13.6	44.9	13.7	44.7	14.5	47
48	46.6	11.7	46.4	12.4	46.1	13.2	45.9	13.9	45.9	14.0	45.6	14.8	48
49	47.5	11.9	47.3	12.7	47.1	13.5	46.9	14.2	46.9	14.3	46.6	15.1	49
50	48.5	12.1	48.3	12.9	48.1	13.8	47.8	14.5	47.8	14.6	47.5	15.4	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	6¾ *Point.*		75 Deg.		74 Deg.		6½ *Point.*		73 Deg.		72 Deg.		

Dist.	1¼ *Point.*		15 Deg.		16 Deg.		1½ *Point.*		17 Deg.		18 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	49.5	12.4	49.3	13.2	49.0	14.0	48.8	14.8	48.8	14.9	48.5	15.8	51
52	50.4	12.6	50.2	13.5	49.9	14.3	49.7	15.1	49.7	15.2	49.4	16.1	52
53	51.4	12.9	51.2	13.7	50.9	14.6	50.7	15.3	50.7	15.5	50.4	16.4	53
54	52.4	13.1	52.2	14.0	51.9	14.9	51.7	15.7	51.6	15.8	51.3	16.7	54
55	53.4	13.4	53.1	14.2	52.9	15.2	52.6	16.0	52.6	16.1	52.3	17.0	55
56	54.3	13.6	54.1	14.5	53.8	15.4	53.6	16.2	53.6	16.4	53.3	17.3	56
57	55.3	13.8	55.1	14.8	54.8	15.7	54.5	16.5	54.5	16.7	54.2	17.6	57
58	56.3	14.1	56.0	15.0	55.7	16.0	55.5	16.8	55.5	17.0	55.2	17.9	58
59	57.3	14.3	57.0	15.3	56.7	16.3	56.5	17.1	56.5	17.2	56.1	18.2	59
60	58.2	14.6	58.0	15.5	57.7	16.5	57.4	17.4	57.4	17.5	57.1	18.5	60
61	59.2	14.8	58.9	15.8	58.6	16.8	58.4	17.7	58.3	17.8	58.0	18.8	61
62	60.1	15.1	59.9	16.1	59.6	17.1	59.3	18.0	59.3	18.1	59.0	19.2	62
63	61.1	15.3	60.8	16.3	60.5	17.4	60.3	18.3	60.2	18.4	59.9	19.5	63
64	62.1	15.5	61.8	16.6	61.5	17.6	61.2	18.6	61.2	18.7	60.9	19.8	64
65	63.0	15.8	62.8	16.8	62.5	17.9	62.2	18.9	62.2	19.0	61.8	20.1	65
66	64.0	16.0	63.7	17.1	63.4	18.2	63.2	19.2	63.1	19.3	62.8	20.4	66
67	65.0	16.3	64.7	17.4	64.4	18.5	64.1	19.4	64.1	19.6	63.7	20.7	67
68	66.0	16.5	65.7	17.6	65.4	18.7	65.1	19.7	65.0	19.9	64.7	21.0	68
69	66.9	16.8	66.6	17.9	66.3	19.0	66.0	20.0	66.0	20.2	65.6	21.3	69
70	67.9	17.0	67.6	18.1	67.3	19.3	67.0	20.3	66.9	20.5	66.6	21.6	70
71	68.9	17.2	68.5	18.3	68.2	19.6	67.9	20.6	67.9	20.8	67.5	21.9	71
72	69.8	17.5	69.5	18.6	69.2	19.8	68.9	20.9	68.8	21.0	68.5	22.2	72
73	70.8	17.7	70.5	18.9	70.2	20.1	69.8	21.2	69.8	21.3	69.4	22.6	73
74	71.8	18.0	71.5	19.1	71.1	20.4	70.8	21.5	70.8	21.6	70.4	22.9	74
75	72.7	18.2	72.4	19.4	72.1	20.7	71.8	21.8	71.7	21.9	71.3	23.2	75
76	73.7	18.5	73.4	19.7	73.1	20.9	72.7	22.1	72.7	22.2	72.3	23.5	76
77	74.7	18.7	74.4	19.9	74.0	21.2	73.7	22.3	73.6	22.5	73.2	23.8	77
78	75.7	18.9	75.3	20.2	75.0	21.5	74.6	22.6	74.6	22.8	74.2	24.1	78
79	76.6	19.2	76.3	20.4	75.9	21.8	75.6	22.9	75.5	23.1	75.1	24.4	79
80	77.6	19.4	77.3	20.7	76.9	22.0	76.6	23.2	76.5	23.4	76.1	24.7	80
81	78.6	19.7	78.2	21.0	77.9	22.3	77.5	23.5	77.5	23.7	77.0	25.0	81
82	79.5	19.9	79.2	21.2	78.8	22.6	78.4	23.8	78.4	24.0	78.0	25.3	82
83	80.5	20.2	80.2	21.5	79.8	22.9	79.4	24.1	79.4	24.3	78.9	25.6	83
84	81.5	20.4	81.1	21.7	80.8	23.1	80.4	24.4	80.3	24.5	79.9	26.0	84
85	82.4	20.7	82.1	22.0	81.7	23.4	81.3	24.7	81.3	24.8	80.8	26.3	85
86	83.4	20.9	83.1	22.3	82.7	23.7	82.3	25.0	82.2	25.1	81.8	26.6	86
87	84.4	21.1	84.0	22.6	83.6	24.0	83.3	25.2	83.2	25.4	82.7	26.9	87
88	85.4	21.4	85.0	22.8	84.6	24.2	84.2	25.5	84.1	25.7	83.7	27.2	88
89	86.3	21.6	86.0	23.0	85.6	24.5	85.2	25.8	85.1	26.0	84.6	27.5	89
90	87.3	21.9	87.0	23.3	86.5	24.8	86.1	26.1	86.1	26.3	85.6	27.8	90
91	88.3	22.1	87.9	23.5	87.5	25.1	87.1	26.4	87.0	26.6	86.5	28.1	91
92	89.2	22.4	88.9	23.8	88.4	25.3	88.0	26.7	88.0	26.9	87.5	28.4	92
93	90.2	22.6	89.8	24.1	89.4	25.6	89.0	27.0	88.9	27.2	88.4	28.7	93
94	91.2	22.8	90.8	24.3	90.4	25.9	90.0	27.3	89.9	27.5	89.4	29.0	94
95	92.1	23.1	91.8	24.6	91.3	26.2	90.9	27.6	90.8	27.8	90.3	29.3	95
96	93.1	23.3	92.7	24.8	92.3	26.4	91.9	27.9	91.8	28.1	91.3	29.7	96
97	94.1	23.5	93.7	25.1	93.2	26.7	92.8	28.2	92.8	28.4	92.3	30.0	97
98	95.1	23.8	94.7	25.4	94.2	27.0	93.8	28.4	93.7	28.6	93.2	30.3	98
99	96.0	24.1	95.6	25.6	95.2	27.3	94.7	28.7	94.7	28.9	94.2	30.6	99
100	97.0	24.3	96.6	25.9	96.1	27.6	95.7	29.0	95.6	29.2	95.1	30.9	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	6¾ *Point.*		75 Deg.		74 Deg.		6½ *Points*		73 Deg.		72 Deg.		

Dift.	19 Deg		1¾ *Point.*		20 Deg.		21 Deg.		22 Deg.		2 Points.		Dift.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.9	00.3	00.9	00.3	00.9	00.3	00.9	00.4	00.9	00.4	00.9	00.4	1
2	01.9	00.6	01.9	00.7	01.9	00.7	01.9	00.7	01.8	00.7	01.8	00.8	2
3	02.8	01.0	02.8	01.0	02.8	01.0	02.8	01.0	02.8	01.1	02.8	01.1	3
4	03.8	01.3	03.8	01.3	03.8	01.4	03.7	01.4	03.7	01.5	03.7	01.5	4
5	04.7	01.6	04.7	01.7	04.7	01.7	04.7	01.8	04.6	01.9	04.6	01.9	5
6	05.7	01.9	05.6	02.0	05.6	02.0	05.6	02.1	05.6	02.2	05.5	02.3	6
7	06.6	02.3	06.6	02.4	06.6	02.4	06.5	02.5	06.5	02.6	06.5	02.7	7
8	07.6	02.6	07.5	02.7	07.5	02.7	07.5	02.9	07.4	03.0	07.4	03.1	8
9	08.5	02.9	08.5	03.0	08.5	03.1	08.4	03.2	08.3	03.4	08.3	03.4	9
10	09.5	03.3	09.4	03.4	09.4	03.4	09.3	03.6	09.3	03.7	09.2	03.8	10
11	10.4	03.6	10.4	03.7	10.3	03.8	10.3	03.9	10.2	04.1	10.2	04.2	11
12	11.3	03.9	11.3	04.0	11.3	04.1	11.2	04.3	11.1	04.5	11.1	04.6	12
13	12.3	04.2	12.2	04.4	12.2	04.4	12.1	04.7	12.0	04.9	12.0	05.0	13
14	13.2	04.6	13.2	04.7	13.2	04.8	13.1	05.0	13.0	05.2	12.9	05.4	14
15	14.2	04.9	14.1	05.1	14.1	05.1	14.0	05.4	13.9	05.6	13.9	05.7	15
16	15.1	05.2	15.1	05.4	15.0	05.4	14.9	05.7	14.8	06.0	14.8	06.1	16
17	16.1	05.5	16.0	05.7	16.0	05.8	15.9	06.1	15.8	06.4	15.7	06.5	17
18	17.0	05.9	16.9	06.1	16.9	06.2	16.8	06.4	16.7	06.7	16.6	06.8	18
19	18.0	06.1	17.9	06.4	17.9	06.5	17.7	06.8	17.6	07.1	17.6	07.2	19
20	18.9	06.5	18.9	06.7	18.8	06.8	18.7	07.2	18.5	07.5	18.5	07.6	20
21	19.9	06.8	19.8	07.1	19.7	07.2	19.6	07.5	19.5	07.9	19.4	08.0	21
22	20.8	07.2	20.7	07.4	20.7	07.5	20.5	07.9	20.4	08.2	20.3	08.4	22
23	21.7	07.5	21.7	07.7	21.6	07.9	21.5	08.2	21.3	08.6	21.2	08.8	23
24	22.7	07.8	22.6	08.1	22.5	08.2	22.4	08.6	22.2	09.0	22.2	09.2	24
25	23.6	08.1	23.5	08.4	23.5	08.5	23.3	09.0	23.2	09.4	23.1	09.6	25
26	24.6	08.5	24.5	08.8	24.4	08.9	24.3	09.3	24.1	09.7	24.0	09.9	26
27	25.5	08.8	25.4	09.1	25.4	09.2	25.2	09.7	25.0	09.1	24.9	10.3	27
28	26.5	09.1	26.4	09.4	26.3	09.6	26.1	10.0	26.0	10.5	25.9	10.7	28
29	27.4	09.4	27.3	09.8	27.2	09.9	27.1	10.4	26.9	10.9	26.8	11.1	29
30	28.4	09.8	28.2	10.1	28.2	10.3	28.0	10.7	27.8	11.2	27.7	11.5	30
31	29.3	10.1	29.2	10.4	29.1	10.6	28.9	11.1	28.7	11.6	28.6	11.9	31
32	30.3	10.4	30.1	10.8	30.1	10.9	29.9	11.5	29.7	12.0	29.6	12.2	32
33	31.2	10.7	31.1	11.1	31.0	11.3	30.8	11.8	30.6	12.4	30.5	12.6	33
34	32.1	11.1	32.0	11.5	31.9	11.6	31.7	12.2	31.5	12.7	31.4	13.0	34
35	33.1	11.4	33.0	11.8	32.9	12.0	32.7	12.5	32.4	13.1	32.3	13.4	35
36	34.0	11.7	33.9	12.1	33.8	12.3	33.6	12.9	33.4	13.5	33.3	13.8	36
37	35.0	12.1	34.8	12.5	34.8	12.6	34.5	13.3	34.3	13.9	34.2	14.2	37
38	35.9	12.4	35.8	12.8	35.7	13.0	35.5	13.6	35.2	14.2	35.1	14.5	38
39	36.9	12.6	36.7	13.1	36.6	13.3	36.4	14.0	36.2	14.6	36.0	14.9	39
40	37.8	13.0	37.7	13.5	37.6	13.7	37.3	14.3	37.1	15.0	36.9	15.3	40
41	38.8	13.3	38.6	13.8	38.5	14.0	38.3	14.7	38.0	15.3	37.9	15.7	41
42	39.7	13.7	39.5	14.1	39.5	14.4	39.2	15.1	38.9	15.7	38.8	16.1	42
43	40.7	14.0	40.5	14.5	40.4	14.7	40.1	15.4	39.9	16.1	39.7	16.5	43
44	41.7	14.3	41.4	14.8	41.3	15.0	41.1	15.8	40.8	16.5	40.6	16.8	44
45	42.6	14.6	42.4	15.2	42.3	15.4	42.0	16.1	41.7	16.8	41.6	17.2	45
46	43.5	15.0	43.3	15.5	43.3	15.7	42.9	16.5	42.6	17.2	42.5	17.6	46
47	44.4	15.3	44.2	15.8	44.2	16.1	43.9	16.8	43.6	17.6	43.4	18.0	47
48	45.4	15.6	45.2	16.2	45.1	16.4	44.8	17.2	44.5	18.0	44.3	18.4	48
49	46.3	15.9	46.1	16.5	46.0	16.8	45.7	17.6	45.4	18.3	45.3	18.7	49
50	47.2	16.3	47.1	16.8	47.0	17.1	46.7	17.9	46.4	18.7	46.2	19.1	50
Dift.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dift.
	71 Deg.		6¼ *Point.*		70 Deg.		69 Deg.		68 Deg.		6 Points.		

Dist.	19 Deg.		1¾ Point.		20 Deg.		21 Deg.		22 Deg.		2 Points.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	48.2	16.6	48.0	17.2	47.9	17.4	47.6	18.3	47.3	19.1	47.1	19.5	51
52	49.2	16.9	49.0	17.5	48.9	17.8	48.5	18.6	48.2	19.4	48.0	19.9	52
53	50.1	17.3	49.9	17.9	49.8	18.1	49.5	19.0	49.1	19.8	49.0	20.3	53
54	51.1	17.6	50.8	18.2	50.7	18.5	50.4	19.3	50.1	20.2	49.9	20.7	54
55	52.0	17.9	51.8	18.5	51.7	18.8	51.3	19.7	51.0	20.6	50.8	21.0	55
56	52.9	18.2	52.7	18.9	52.6	19.2	52.3	20.1	51.9	21.0	51.7	21.4	56
57	53.9	18.6	53.7	19.2	53.6	19.5	53.2	20.4	52.8	21.3	52.7	21.8	57
58	54.8	18.9	54.6	19.5	54.5	19.8	54.3	20.8	53.8	21.7	53.6	22.2	58
59	55.8	19.2	55.5	19.9	55.4	20.2	55.1	21.1	54.7	22.1	54.5	22.6	59
60	56.7	19.5	56.5	20.2	56.4	20.5	56.0	21.5	55.6	22.5	55.4	23.0	60
61	57.7	19.9	57.4	20.5	57.3	20.8	56.9	21.9	56.5	22.8	56.4	23.3	61
62	58.6	20.2	58.4	20.9	58.3	21.0	57.9	22.2	57.5	23.2	57.3	23.7	62
63	59.6	20.5	59.3	21.2	59.2	21.5	58.8	22.6	58.4	23.6	58.2	24.1	63
64	60.5	20.8	60.3	21.6	60.1	21.9	59.7	22.9	59.3	24.0	59.1	24.5	64
65	61.5	21.2	61.2	21.9	61.1	22.2	60.7	23.3	60.3	24.3	60.0	24.9	65
66	62.4	21.5	62.1	22.2	62.9	22.6	61.6	23.6	61.2	24.7	61.0	25.3	66
67	63.3	21.8	63.1	22.6	63.0	22.9	62.5	24.0	62.1	25.1	61.9	25.6	67
68	64.3	22.1	64.0	22.9	63.9	23.3	63.5	24.4	63.0	25.5	62.8	26.0	68
69	65.2	22.5	65.0	23.2	64.8	23.6	64.4	24.7	64.0	25.8	63.7	26.4	69
70	66.2	22.8	65.9	23.6	65.8	23.9	65.3	25.1	64.9	26.2	64.7	26.8	70
71	67.1	23.1	66.8	23.9	66.7	24.3	66.3	25.4	65.8	26.6	65.6	27.2	71
72	68.1	23.4	67.8	24.2	67.7	24.6	67.2	15.8	66.7	27.0	66.5	27.6	72
73	69.0	23.8	68.7	24.6	68.6	25.0	68.1	26.2	67.7	27.3	67.4	27.9	73
74	70.0	24.1	69.7	24.9	69.5	25.3	69.1	26.5	68.6	27.7	68.4	28.3	74
75	70.9	24.4	70.6	25.3	70.5	25.6	70.0	26.9	69.5	28.1	69.3	28.7	75
76	71.9	24.7	71.6	25.6	71.4	26.0	70.9	27.2	70.5	28.5	70.2	29.1	76
77	72.8	25.1	72.5	25.9	72.4	26.3	71.9	27.6	71.4	28.8	71.1	29.5	77
78	73.7	25.4	73.4	26.3	73.3	26.7	72.8	27.9	72.3	29.2	72.1	29.8	78
79	74.7	25.7	74.4	26.6	74.2	27.0	73.7	28.3	73.2	29.6	73.0	30.2	79
80	75.6	26.0	75.3	26.9	75.2	27.4	74.7	28.7	74.2	30.0	73.9	30.6	80
81	76.6	26.4	76.3	27.3	76.1	27.7	75.6	29.0	75.1	30.3	74.8	31.0	81
82	77.5	26.7	77.2	27.6	77.1	28.0	76.5	29.4	76.0	30.7	75.8	31.4	82
83	78.5	27.0	78.1	28.	78.0	28.4	77.5	29.7	76.9	31.1	76.7	31.8	83
84	79.4	27.3	79.1	28.3	78.9	28.7	78.4	30.1	77.9	31.5	77.6	32.1	84
85	80.4	27.7	80.1	28.6	79.9	29.1	79.3	30.5	78.8	31.8	78.6	32.5	85
86	81.3	28.0	81.0	29.0	80.8	29.4	80.3	30.8	79.7	32.2	79.4	32.9	86
87	82.3	28.3	81.9	29.3	81.8	29.7	81.2	31.2	80.7	32.6	80.4	33.3	87
88	83.2	28.6	82.8	29.6	82.7	30.1	82.1	31.5	81.6	33.0	81.3	33.7	88
89	84.1	29.0	83.8	30.0	83.6	30.4	83.1	31.9	82.5	33.3	82.2	34.1	89
90	85.1	29.3	84.7	30.3	84.6	30.8	84.0	32.3	83.4	33.7	83.1	34.4	90
91	86.0	29.6	85.7	30.7	85.5	31.1	84.9	32.6	84.4	34.1	84.1	34.8	91
92	87.0	29.9	86.6	31.0	86.4	31.5	85.9	33.0	85.3	34.5	85.0	35.2	92
93	88.0	30.3	87.6	31.3	87.4	31.8	86.8	33.3	86.2	34.8	85.9	35.6	93
94	88.9	30.6	88.5	31.7	88.3	32.1	87.7	33.7	87.2	35.2	86.8	36.0	94
95	89.8	30.9	89.4	32.0	89.3	32.5	88.7	34.0	88.1	35.6	87.8	36.3	95
96	90.8	31.3	90.4	32.3	90.2	32.8	89.6	34.4	89.0	35.9	88.7	36.7	96
97	91.7	31.6	91.3	32.7	91.1	33.2	90.5	34.8	89.9	36.3	89.6	37.1	97
98	92.7	31.9	92.3	33.0	92.1	33.5	91.5	35.1	90.9	36.7	90.5	37.5	98
99	93.6	32.2	93.2	33.3	93.0	33.9	92.4	35.5	91.8	37.1	91.5	37.9	99
100	94.5	32.6	94.2	33.7	94.0	34.2	93.4	35.8	92.7	37.5	92.4	38.3	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	71 Deg.		6¼ Point.		70 Deg.		69 Deg.		68 Deg.		6 Points.		

Dist.	23 Deg.		24 Deg.		25 Deg.		2¼ *Point.*		26 Deg.		27 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	00.9	00.4	1
2	01.8	00.8	01.8	00.8	01.8	00.8	01.8	00.9	01.8	00.9	01.8	00.9	2
3	02.8	01.2	02.7	01.2	02.7	01.3	02.7	01.3	02.7	01.3	02.7	01.4	3
4	03.7	01.6	03.6	01.6	03.6	01.7	03.6	01.7	03.6	01.7	03.6	01.8	4
5	04.6	01.9	04.6	02.0	04.5	02.1	04.5	02.1	04.5	02.2	04.5	02.3	5
6	05.5	02.3	05.5	02.4	05.4	02.5	05.4	02.6	05.4	02.6	05.3	02.7	6
7	06.4	02.7	06.4	02.8	06.3	03.0	06.3	03.0	06.3	03.1	06.2	03.2	7
8	07.4	03.1	07.3	03.2	07.2	03.4	07.2	03.4	07.2	03.5	07.1	03.6	8
9	08.3	03.5	08.2	03.7	08.2	03.8	08.1	03.8	08.1	03.9	08.0	04.1	9
10	09.2	03.9	09.1	04.1	09.1	04.2	09.0	04.3	09.0	04.4	08.9	04.5	10
11	10.1	04.3	10.0	04.5	10.0	04.6	09.9	04.7	09.9	04.8	09.8	05.0	11
12	11.0	04.7	11.0	04.9	10.9	05.1	10.8	05.1	10.8	05.3	10.7	05.4	12
13	12.0	05.1	11.9	05.3	11.8	05.5	11.7	05.6	11.7	05.7	11.6	05.9	13
14	12.9	05.5	12.8	05.7	12.7	05.9	12.7	05.9	12.6	06.1	12.5	06.4	14
15	13.8	05.9	13.7	06.1	13.6	06.3	13.6	06.4	13.5	06.6	13.4	06.8	15
16	14.7	06.2	14.6	06.5	14.5	06.8	14.5	06.8	14.4	07.0	14.3	07.3	16
17	15.6	06.6	15.5	06.9	15.4	07.2	15.4	07.3	15.3	07.4	15.1	07.7	17
18	16.6	07.0	16.4	07.3	16.3	07.6	16.3	07.7	16.2	07.9	16.0	08.2	18
19	17.5	07.4	17.4	07.7	17.2	08.0	17.2	08.1	17.1	08.3	16.9	08.6	19
20	18.4	07.8	18.3	08.1	18.1	08.4	18.1	08.5	18.0	08.8	17.8	09.1	20
21	19.3	08.2	19.2	08.5	19.0	08.9	19.0	09.0	18.9	09.2	18.7	09.5	21
22	20.2	08.6	20.1	08.9	19.9	09.3	19.9	09.4	19.8	09.9	19.6	10.0	22
23	21.2	09.0	21.0	09.3	20.8	09.7	20.8	09.8	20.7	10.1	20.5	10.4	23
24	22.1	09.4	21.9	09.8	21.7	10.1	21.7	10.3	21.6	10.5	21.4	10.9	24
25	23.0	09.8	22.8	10.2	22.7	10.6	22.6	10.7	22.5	11.0	22.3	11.3	25
26	23.9	10.2	23.7	10.6	23.6	11.0	23.5	11.1	23.4	11.4	23.2	11.8	26
27	24.8	10.5	24.7	11.0	24.5	11.4	24.4	11.5	24.3	11.8	24.1	12.2	27
28	25.8	10.9	25.6	11.4	25.4	11.8	25.3	12.0	25.2	12.3	24.9	12.7	28
29	26.7	11.3	26.5	11.8	26.3	12.3	26.2	12.4	26.1	12.7	25.8	13.2	29
30	27.6	11.7	27.4	12.2	27.2	12.7	27.1	12.8	27.0	13.1	26.7	13.6	30
31	28.5	12.1	28.3	12.6	28.1	13.1	28.0	13.3	27.9	13.6	27.6	14.1	31
32	29.5	12.5	29.2	13.0	29.0	13.5	28.9	13.7	28.8	14.0	28.5	14.5	32
33	30.4	12.9	30.1	13.4	29.9	13.9	29.8	14.1	29.6	14.4	29.4	15.0	33
34	31.3	13.3	31.1	13.8	30.8	14.4	30.7	14.5	30.6	14.9	30.3	15.4	34
35	32.2	13.7	32.0	14.2	31.7	14.8	31.6	15.0	31.5	15.3	31.2	15.9	35
36	33.1	14.1	32.9	14.6	32.6	15.2	32.5	15.4	32.4	15.8	32.1	16.3	36
37	34.1	14.4	33.8	15.0	33.5	15.6	33.4	15.8	33.2	16.2	33.0	16.8	37
38	35.0	14.8	34.7	15.4	34.4	16.0	34.3	16.2	34.0	16.6	33.9	17.2	38
39	35.9	15.2	35.6	15.9	35.3	16.5	35.3	16.7	35.1	17.1	34.7	17.7	39
40	36.8	15.6	36.5	16.3	36.2	16.9	36.2	17.1	35.9	17.5	35.6	18.2	40
41	37.7	16.0	37.5	16.7	37.2	17.3	37.1	17.5	36.8	18.0	36.5	18.6	41
42	38.7	16.4	38.4	17.1	38.1	17.7	38.0	18.0	37.7	18.4	37.4	19.1	42
43	39.6	16.8	39.3	17.5	39.0	18.2	38.9	18.4	38.6	18.8	38.3	19.5	43
44	40.5	17.2	40.2	17.9	39.9	18.6	39.8	18.8	39.5	19.3	39.2	20.0	44
45	41.4	17.6	41.1	18.3	40.8	19.0	40.7	19.2	40.4	19.7	40.1	20.4	45
46	42.3	18.0	42.0	18.7	41.7	19.4	41.6	19.7	41.3	20.2	41.0	20.9	46
47	43.3	18.4	42.9	19.1	42.6	19.9	42.5	20.1	42.2	20.6	41.9	21.3	47
48	44.2	18.8	43.8	19.5	43.5	20.3	43.4	20.5	43.1	21.0	42.8	21.8	48
49	45.1	19.2	44.8	19.9	44.4	20.7	44.3	20.9	44.0	21.5	43.7	22.2	49
50	46.0	19.5	45.7	20.3	45.3	21.1	45.2	21.4	44.9	21.9	44.5	22.7	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	67 Deg.		66 Deg.		65 Deg.		5¾ *Point.*		64 Deg.		63 Deg.		

Diff.	23 Deg.		24 Deg.		25 Deg.		2½ *Point.*		26 Deg.		27 Deg.		Diff.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	46.9	19.9	46.6	20.7	46.2	21.5	46.1	21.8	45.8	22.3	45.4	23.2	51
52	47.9	20.3	47.5	21.1	47.1	22.0	47.0	22.2	46.7	22.8	46.3	23.6	52
53	48.8	20.7	48.4	21.5	48.0	22.4	47.9	22.7	47.6	23.2	47.2	24.1	53
54	49.7	21.1	49.3	22.0	48.9	22.8	48.8	23.1	48.5	23.7	48.1	24.5	54
55	50.6	21.5	50.2	22.4	49.8	23.2	49.7	23.5	49.4	24.1	49.0	25.0	55
56	51.5	21.9	51.2	22.8	50.7	23.7	50.6	23.9	50.4	24.5	49.9	25.4	56
57	52.5	22.3	52.1	23.2	51.7	24.1	51.5	24.4	51.2	25.0	50.8	25.9	57
58	53.4	22.7	53.0	23.6	52.6	24.5	52.4	24.8	52.1	25.4	51.7	26.3	58
59	54.3	23.0	53.9	24.0	53.5	24.9	53.3	25.2	53.0	25.9	52.6	26.2	59
60	55.2	23.4	54.8	24.4	54.4	25.4	54.2	25.6	53.9	26.3	53.5	27.2	60
61	56.1	23.8	55.7	24.8	55.3	25.8	55.1	26.1	54.8	26.7	54.4	27.7	61
62	57.1	24.2	56.6	25.2	56.2	26.2	56.0	26.5	55.7	27.2	55.2	28.1	62
63	58.0	24.6	57.5	25.6	57.1	26.6	56.9	26.9	56.6	27.6	56.1	28.6	63
64	58.9	25.0	58.5	26.0	58.0	27.0	57.9	27.4	57.5	28.0	57.0	29.1	64
65	59.8	25.4	59.4	26.4	58.9	27.5	58.8	27.8	58.4	28.5	57.9	29.5	65
66	60.7	25.8	60.3	26.8	59.8	27.9	59.7	28.2	59.3	28.9	58.8	30.0	66
67	61.7	26.2	61.2	27.2	60.7	28.3	60.6	28.6	60.2	29.4	59.7	30.4	67
68	62.6	26.6	62.1	27.7	61.6	28.7	61.5	29.1	61.1	29.8	60.6	30.9	68
69	63.5	27.0	63.0	28.1	62.5	29.2	62.4	29.5	62.0	30.2	61.5	31.3	69
70	64.4	27.3	63.9	28.5	63.4	29.6	63.3	29.9	62.9	30.7	62.4	31.8	70
71	65.4	27.7	64.9	28.9	64.3	30.0	64.2	30.4	63.8	31.1	63.3	32.2	71
72	66.3	28.1	65.8	29.3	65.2	30.4	65.1	30.8	64.7	31.6	64.2	32.7	72
73	67.2	28.5	66.7	29.7	66.2	30.8	66.0	31.2	65.6	32.0	65.0	33.1	73
74	68.1	28.9	67.6	30.1	67.1	31.3	66.9	31.6	66.5	32.4	65.9	33.6	74
75	69.0	29.3	68.5	30.5	68.0	31.7	67.8	32.1	67.4	32.9	66.8	34.1	75
76	70.0	29.7	69.4	30.9	68.9	32.1	68.7	32.5	68.3	33.3	67.7	34.5	76
77	70.9	30.1	70.3	31.3	69.8	32.5	69.6	32.9	69.2	33.7	68.6	35.0	77
78	71.8	30.5	71.2	31.7	70.7	33.0	70.5	33.3	70.1	34.2	69.5	35.4	78
79	72.7	30.9	72.2	32.1	71.6	33.5	71.4	33.8	71.0	34.6	70.4	35.9	79
80	73.6	31.3	73.1	32.5	72.5	33.8	72.3	34.2	71.9	35.1	71.3	36.3	80
81	74.6	31.6	74.0	32.9	73.4	34.2	73.2	34.6	72.8	35.5	72.2	36.8	81
82	75.5	32.0	74.9	33.3	74.3	34.7	74.1	35.1	73.7	35.9	73.1	37.2	82
83	76.4	32.4	75.8	33.8	75.2	35.1	75.0	35.5	74.6	36.4	74.0	37.7	83
84	77.3	32.8	76.7	34.2	76.1	35.5	75.9	35.9	75.5	36.8	74.8	38.1	84
85	78.2	33.2	77.6	34.6	77.0	35.9	76.8	36.3	76.4	37.3	75.7	38.6	85
86	79.2	33.6	78.6	35.0	77.9	36.3	77.7	36.8	77.3	37.7	76.6	39.0	86
87	80.1	34.0	79.5	35.4	78.8	36.8	78.6	37.2	78.2	38.1	77.5	39.5	87
88	81.0	34.4	80.4	35.8	79.7	37.2	79.5	37.6	79.1	38.6	78.4	40.0	88
89	81.9	34.8	81.3	36.2	80.7	37.6	80.5	38.1	80.0	39.0	79.3	40.4	89
90	82.8	35.2	82.2	36.6	81.6	38.0	81.4	38.5	80.9	39.4	80.2	40.9	90
91	83.7	35.6	83.1	37.0	82.5	38.5	82.3	38.9	81.8	39.8	81.1	41.3	91
92	84.7	35.9	84.0	37.4	83.4	38.9	83.2	39.3	82.7	40.3	82.0	41.8	92
93	85.6	36.3	85.0	37.8	84.3	39.3	84.1	39.8	83.6	40.8	82.9	42.2	93
94	86.4	36.7	85.9	38.2	85.2	39.7	85.0	40.2	84.5	41.2	83.8	42.7	94
95	87.4	37.1	86.8	38.6	86.1	40.1	85.9	40.6	85.4	41.5	84.6	43.1	95
96	88.4	37.5	87.7	39.0	87.0	40.6	86.8	41.0	86.3	42.1	85.5	43.6	96
97	89.4	37.9	88.6	39.4	87.9	41.0	87.7	41.5	87.2	42.5	86.4	44.0	97
98	90.2	38.3	89.5	39.9	88.8	41.4	88.6	41.9	88.1	43.0	87.3	44.4	98
99	91.1	38.7	90.4	40.3	89.7	41.8	89.5	42.3	89.0	43.4	88.2	44.9	99
100	92.0	39.1	91.4	40.7	90.6	42.3	90.4	42.7	89.9	43.8	89.1	45.4	100
Diff.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Diff.
	67 Deg.		66 Deg.		65 Deg.		5¾ *Point.*		64 Deg.		63 Deg.		

Dist.	28 Deg.		2½ *Point.*		29 Deg.		30 Deg.		2¾ *Point.*		31 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.9	00.5	00.9	00.5	00.9	00.5	00.9	00.5	00.9	00.5	00.9	00.5	1
2	01.8	00.9	01.8	00.9	01.7	01.0	01.7	01.0	01.7	01.0	01.7	01.0	2
3	02.6	01.4	02.6	01.4	02.6	01.4	02.6	01.5	02.6	01.5	02.6	01.5	3
4	03.5	01.9	03.5	01.9	03.5	01.9	03.5	02.0	03.4	02.1	03.4	02.1	4
5	04.4	02.3	04.4	02.4	04.4	02.4	04.3	02.5	04.3	02.6	04.3	02.6	5
6	05.3	02.8	05.3	02.8	05.2	02.9	05.2	03.0	05.1	03.1	05.1	03.1	6
7	06.2	03.3	06.2	03.3	06.1	03.4	06.1	03.5	06.0	03.6	06.0	03.6	7
8	07.1	03.8	07.1	03.8	07.0	03.9	07.0	04.0	06.9	04.1	06.9	04.1	8
9	07.9	04.2	07.9	04.2	07.9	04.4	07.8	04.5	07.7	04.6	07.7	04.6	9
10	08.8	04.7	08.8	04.7	08.7	04.8	08.7	05.0	08.6	05.1	08.6	05.1	10
11	09.7	05.2	09.7	05.2	09.6	05.3	09.5	05.5	09.4	05.6	09.4	05.7	11
12	10.6	05.6	10.6	05.6	10.5	05.8	10.4	06.0	10.3	06.2	10.3	06.2	12
13	11.5	06.1	11.5	06.1	11.4	06.3	11.3	06.5	11.1	06.7	11.1	06.7	13
14	12.3	06.6	12.3	06.6	12.2	06.8	12.1	07.0	12.0	07.2	12.0	07.2	14
15	13.2	07.0	13.2	07.1	13.1	07.3	13.0	07.5	12.9	07.7	12.9	07.7	15
16	14.1	07.5	14.1	07.5	14.0	07.7	13.9	08.0	13.7	08.2	13.7	08.2	16
17	15.0	08.0	15.0	08.0	14.9	08.2	14.7	08.5	14.6	08.7	14.6	08.8	17
18	15.9	08.4	15.9	08.5	15.7	08.7	15.6	09.0	15.4	09.2	15.4	09.3	18
19	16.8	08.9	16.8	08.9	16.6	09.2	16.4	09.5	16.3	09.8	16.3	09.8	19
20	17.7	09.4	17.6	09.4	17.5	09.7	17.3	10.0	17.1	10.3	17.1	10.3	20
21	18.5	09.9	18.5	09.9	18.4	10.2	18.2	10.5	18.0	10.8	18.0	10.8	21
22	19.4	10.3	19.4	10.3	19.2	10.7	19.0	11.0	18.9	11.3	18.9	11.3	22
23	20.3	10.8	20.3	10.8	20.1	11.1	19.9	11.5	19.7	11.8	19.7	11.8	23
24	21.2	11.3	21.2	11.3	21.0	11.6	20.8	12.0	20.6	12.3	20.6	12.4	24
25	22.1	11.7	22.0	11.8	21.9	12.1	21.6	12.5	21.4	12.8	21.4	12.9	25
26	23.0	12.3	22.9	12.3	22.7	12.6	22.5	13.0	22.3	13.4	22.3	13.4	26
27	23.8	12.7	23.8	12.7	23.6	13.1	23.4	13.5	23.1	13.9	23.1	13.9	27
28	24.7	13.1	24.7	13.2	24.5	13.6	24.2	14.0	24.0	14.4	24.0	14.4	28
29	25.6	13.6	25.6	13.7	25.4	14.1	25.1	14.5	24.9	14.9	24.9	14.9	29
30	26.5	14.1	26.5	14.1	26.2	14.5	26.0	15.0	25.7	15.4	25.7	15.4	30
31	27.4	14.5	27.3	14.6	27.1	15.0	26.8	15.5	26.6	15.9	26.6	16.0	31
32	28.2	15.0	28.2	15.1	28.0	15.5	27.7	16.0	27.4	16.4	27.4	16.5	32
33	29.1	15.6	29.1	15.5	28.9	16.0	28.6	16.5	28.3	17.0	28.3	17.0	33
34	30.0	16.0	30.0	16.0	29.7	16.5	29.5	17.0	29.2	17.5	29.1	17.5	34
35	30.9	16.4	30.9	16.5	30.6	17.0	30.3	17.5	30.0	18.0	30.0	18.0	35
36	31.8	16.9	31.7	17.0	31.5	17.4	31.2	18.0	30.9	18.5	30.9	18.5	36
37	32.7	17.4	32.6	17.4	32.4	17.9	32.0	18.5	31.7	19.0	31.7	19.1	37
38	33.5	17.9	33.5	17.9	33.2	18.4	32.9	19.0	32.5	19.5	32.6	19.6	38
39	34.4	18.3	34.4	18.4	34.1	18.9	33.8	19.5	33.4	20.0	33.4	20.1	39
40	35.3	18.8	35.3	18.6	35.0	19.4	34.6	20.0	34.3	20.6	34.3	20.6	40
41	36.2	19.3	36.1	19.3	35.8	19.9	35.5	20.5	35.2	21.1	35.1	21.1	41
42	37.1	19.7	37.0	19.8	36.7	20.4	36.4	21.0	36.0	21.6	36.0	21.6	42
43	38.0	20.1	37.9	20.3	37.6	20.8	37.2	21.5	36.9	22.1	36.9	22.1	43
44	38.8	20.6	38.8	20.7	38.5	21.3	38.1	22.0	37.7	22.6	37.7	22.6	44
45	39.7	21.1	39.7	21.2	39.3	21.8	39.0	22.5	38.6	23.1	38.6	23.2	45
46	40.6	21.6	40.6	21.7	40.2	22.3	39.8	23.0	39.5	23.6	39.4	23.7	46
47	41.5	22.1	41.4	22.2	41.1	22.8	40.7	23.5	40.3	24.2	40.3	24.2	47
48	42.4	22.5	42.3	22.6	42.0	23.3	41.6	24.0	41.3	24.7	41.1	24.7	48
49	43.3	23.0	43.2	23.2	42.8	23.7	42.4	24.5	42.0	25.2	42.0	25.2	49
50	44.1	23.5	44.1	23.6	43.7	24.2	43.3	25.0	42.9	25.7	42.9	25.7	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	62 Deg.		5½ *Point.*		61 Deg.		60 Deg.		5¼ *Point.*		59 Deg.		

Dist.	28 Deg.		2½ *Point*.		29 Deg.		30 Deg.		2¾ *Point*.		31 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	45.0	23.9	45.0	24.0	44.6	24.7	44.2	25.5	43.7	26.2	43.7	26.3	51
52	45.9	24.4	45.9	24.5	45.5	25.2	45.0	26.0	44.6	26.7	44.6	26.8	52
53	46.8	24.9	46.7	25.0	46.3	25.7	45.9	26.5	45.5	27.2	45.4	27.3	53
54	47.7	25.3	47.6	25.5	47.2	26.2	46.8	27.0	46.3	27.8	46.3	27.8	54
55	48.6	25.8	48.5	25.9	48.1	26.7	47.6	27.5	47.2	28.3	47.1	28.3	55
56	49.4	26.3	49.4	26.4	49.0	27.1	48.5	28.0	48.0	28.8	48.0	28.8	56
57	50.3	26.8	50.3	26.9	49.8	27.6	49.4	28.5	48.9	29.3	48.9	29.4	57
58	51.2	27.2	51.2	27.3	50.7	28.1	50.2	29.0	49.7	29.8	49.7	29.9	58
59	52.1	27.7	52.0	27.8	51.6	28.6	51.1	29.5	50.6	30.3	50.6	30.4	59
60	53.0	28.2	52.9	28.3	52.5	29.1	52.0	30.0	51.5	30.8	51.4	30.9	60
61	53.9	28.6	53.8	28.7	53.3	29.6	52.8	30.5	52.3	31.4	52.3	31.4	61
62	54.7	29.1	54.7	29.2	54.2	30.1	53.7	31.0	53.2	31.9	53.1	31.9	62
63	55.6	29.6	55.6	29.7	55.1	30.5	54.6	31.5	54.0	32.4	54.0	32.4	63
64	56.5	30.0	56.4	30.2	56.0	31.0	55.4	32.0	54.9	32.9	54.9	33.0	64
65	57.4	30.5	57.3	30.5	56.8	31.5	56.3	32.5	55.7	33.4	55.7	33.5	65
66	58.3	31.0	58.2	31.1	57.7	32.0	57.2	33.0	56.6	33.9	56.6	34.0	66
67	59.2	31.4	59.1	31.6	58.6	32.5	58.0	33.5	57.5	34.4	57.4	34.5	67
68	60.0	31.9	60.0	32.0	59.5	33.0	58.9	34.0	58.3	35.0	58.3	35.0	68
69	60.9	32.4	60.8	32.5	60.3	33.4	59.7	34.5	59.2	35.5	59.1	35.5	69
70	61.8	32.9	61.7	33.0	61.2	33.9	60.6	35.0	60.0	36.0	60.0	36.0	70
71	62.7	33.3	62.6	33.5	62.1	34.4	61.5	35.5	60.9	36.5	60.9	36.6	71
72	63.6	33.8	63.5	33.9	63.0	34.9	62.3	36.0	61.8	37.0	61.7	37.1	72
73	64.4	34.3	64.4	34.4	63.8	35.4	63.2	36.5	62.6	37.5	62.6	37.6	73
74	65.3	34.7	65.3	34.9	64.7	35.9	64.1	37.0	63.5	38.0	63.4	38.1	74
75	66.2	35.2	66.1	35.4	65.6	36.4	64.9	37.5	64.3	38.6	64.3	38.6	75
76	67.1	35.7	67.0	35.8	66.5	36.8	65.8	38.0	65.2	39.1	65.1	39.1	76
77	68.0	36.1	67.9	36.3	67.3	37.3	66.7	38.5	66.0	39.6	66.0	39.7	77
78	68.9	36.6	68.8	36.8	68.2	37.8	67.5	39.0	66.9	40.1	66.9	40.2	78
79	69.7	37.1	69.7	37.2	69.1	38.3	68.4	39.5	67.8	40.6	67.7	40.7	79
80	70.6	37.6	70.5	37.7	70.0	38.8	69.3	40.0	68.6	41.1	68.6	41.2	80
81	71.5	38.0	71.4	38.2	70.8	39.3	70.1	40.5	69.4	41.6	69.4	41.7	81
82	72.4	38.5	72.3	38.6	71.7	39.7	70.9	41.0	70.3	42.2	70.3	42.2	82
83	73.3	39.0	73.2	39.1	72.6	40.2	71.8	41.5	71.2	42.7	71.1	42.7	83
84	74.2	39.4	74.1	39.6	73.5	40.7	72.7	42.0	72.1	43.2	72.0	43.3	84
85	75.0	39.9	75.0	40.1	74.3	41.2	73.6	42.5	72.9	43.7	72.9	43.8	85
86	75.9	40.4	75.8	40.5	75.2	41.7	74.5	43.0	73.8	44.2	73.7	44.3	86
87	76.8	40.8	76.7	41.0	76.1	42.2	75.3	43.5	74.6	44.7	74.6	44.8	87
88	77.7	41.3	77.6	41.5	77.0	42.7	76.2	44.0	75.5	45.2	75.4	45.3	88
89	78.6	41.8	78.5	41.9	77.8	43.1	77.1	44.5	76.3	45.8	76.3	45.8	89
90	79.5	42.2	79.4	42.4	78.7	43.6	77.9	45.0	77.2	46.3	77.1	46.3	90
91	80.3	42.7	80.2	42.9	79.6	44.1	78.8	45.5	78.1	46.8	78.0	46.9	91
92	81.2	43.2	81.1	43.4	80.5	44.6	79.7	46.0	78.9	47.3	78.9	47.4	92
93	82.1	43.6	82.0	43.8	81.3	45.1	80.5	47.5	79.8	47.8	79.7	47.9	93
94	83.0	44.1	82.9	44.3	82.2	45.6	81.4	47.0	80.6	48.3	80.6	48.4	94
95	83.9	44.6	83.8	44.8	83.1	46.1	82.3	47.5	81.5	48.8	81.4	48.9	95
96	84.8	45.1	84.7	45.2	84.0	46.5	83.1	48.0	82.3	49.3	82.3	49.4	96
97	85.6	45.5	85.5	45.7	84.8	47.0	84.0	48.5	83.2	49.9	83.1	50.0	97
98	86.5	46.0	86.4	46.2	85.7	47.5	84.9	49.0	84.1	50.4	84.0	50.5	98
99	87.4	46.5	87.3	46.7	86.6	48.0	85.7	49.5	84.9	50.0	84.9	51.0	99
100	88.3	46.9	88.2	47.1	87.5	48.5	86.6	50.0	85.8	51.4	85.7	51.5	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	62 Deg.		5½ *Point*.		61 Deg.		60 Deg.		5½ *Point*.		59 Deg.		

Dist.	32 Deg.		33 Deg.		3 Points.		34 Deg.		35 Deg.		36 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.8	00.5	00.8	00.5	00.8	00.6	00.8	00.6	00.8	00.6	00.8	00.6	1
2	01.7	01.1	01.7	01.1	01.7	01.1	01.7	01.1	01.6	01.1	01.6	01.2	2
3	02.5	01.6	02.5	01.6	02.5	01.7	02.5	01.7	02.5	01.7	02.4	01.8	3
4	03.4	02.1	03.4	02.2	03.3	02.2	03.3	02.2	03.3	02.3	03.2	02.3	4
5	04.2	02.6	04.2	02.7	04.2	02.8	04.1	02.8	04.1	02.9	04.0	02.9	5
6	05.1	03.2	05.0	03.3	05.0	03.3	05.0	03.4	04.9	03.4	04.8	03.5	6
7	05.9	03.7	05.9	03.8	05.8	03.9	05.8	03.9	05.7	04.0	05.7	04.1	7
8	06.8	04.2	06.7	04.4	06.6	04.4	06.6	04.5	06.5	04.6	06.5	04.7	8
9	07.6	04.8	07.5	04.9	07.5	05.0	07.5	05.0	07.4	05.2	07.3	05.3	9
10	08.5	05.3	08.4	05.4	08.3	05.6	08.3	05.6	08.2	05.7	08.1	05.9	10
11	09.3	05.8	09.2	06.0	09.1	06.1	09.1	06.1	09.0	06.3	08.9	06.5	11
12	10.2	06.4	10.1	06.5	10.0	06.7	09.9	06.7	09.8	06.9	09.7	07.0	12
13	11.0	06.9	10.9	07.1	10.8	07.2	10.8	07.3	10.6	07.5	10.5	07.6	13
14	11.9	07.4	11.7	07.6	11.6	07.8	11.6	07.8	11.5	08.0	11.3	08.2	14
15	12.7	07.9	12.6	08.2	12.5	08.3	12.4	08.4	12.3	08.6	12.1	08.8	15
16	13.6	08.5	13.4	08.7	13.3	08.9	13.3	08.9	13.1	09.2	12.9	09.4	16
17	14.4	09.0	14.3	09.3	14.1	09.4	14.1	09.5	13.9	09.8	13.7	10.0	17
18	15.3	09.5	15.1	09.8	15.0	10.0	14.9	10.1	14.7	10.3	14.6	10.6	18
19	16.1	10.1	15.9	10.3	15.8	10.6	15.7	10.6	15.6	10.9	15.4	11.2	19
20	17.0	10.6	16.8	10.9	16.6	11.1	16.6	11.2	16.4	11.5	16.2	11.8	20
21	17.8	11.1	17.6	11.4	17.5	11.7	17.4	11.7	17.2	12.0	17.0	12.3	21
22	18.6	11.7	18.5	12.0	18.3	12.2	18.2	12.3	18.0	12.6	17.8	12.9	22
23	19.5	12.2	19.3	12.5	19.1	12.8	19.0	12.8	18.8	13.2	18.6	13.5	23
24	20.3	12.7	20.1	13.1	20.0	13.3	19.9	13.4	19.7	13.8	19.4	14.1	24
25	21.2	13.2	21.0	13.6	20.7	13.9	20.7	14.0	20.5	14.3	20.1	14.7	25
26	22.0	13.8	21.8	14.2	21.6	14.4	21.5	14.5	21.3	14.9	21.0	15.3	26
27	22.9	14.3	22.6	14.7	22.4	15.0	22.4	15.1	22.1	15.5	21.8	15.9	27
28	23.7	14.8	23.5	15.2	23.3	15.5	23.2	15.6	22.9	16.1	22.6	16.5	28
29	24.6	15.4	24.3	15.8	24.1	16.1	24.0	16.2	23.8	16.6	23.4	17.0	29
30	25.4	15.9	25.2	16.3	24.9	16.7	24.9	16.8	24.6	17.2	24.3	17.6	30
31	26.3	16.4	26.0	16.9	25.8	17.2	25.7	17.3	25.4	17.8	25.1	18.2	31
32	27.1	17.0	26.8	17.4	26.6	17.8	26.5	17.9	26.2	18.3	25.9	18.8	32
33	28.0	17.5	27.7	18.0	27.4	18.3	27.4	18.4	27.0	18.9	26.7	19.4	33
34	28.8	18.0	28.5	18.5	28.3	18.9	28.2	19.0	27.9	19.5	27.5	20.0	34
35	29.7	18.5	29.4	19.1	29.1	19.4	29.0	19.6	28.7	20.1	28.3	20.6	35
36	30.5	19.1	30.2	19.6	29.9	20.0	29.8	20.1	29.5	20.6	29.1	21.2	36
37	31.4	19.6	31.0	20.1	30.8	20.6	30.7	20.7	30.3	21.2	29.9	21.7	37
38	32.2	20.1	31.9	20.7	31.6	21.1	31.4	21.2	31.1	21.8	30.7	22.3	38
39	33.1	20.7	32.7	21.2	32.4	21.7	32.3	21.8	32.0	22.3	31.5	22.9	39
40	33.9	21.2	33.6	21.8	33.3	22.2	33.2	22.4	32.8	22.9	32.4	23.5	40
41	34.8	21.7	34.4	22.3	34.1	22.8	34.0	22.9	33.6	23.5	33.2	24.1	41
42	35.6	22.3	35.2	22.9	34.9	23.3	34.8	23.5	34.4	24.1	34.0	24.7	42
43	36.5	22.8	36.1	23.4	35.7	23.9	35.6	24.0	35.2	24.6	34.8	25.3	43
44	37.3	23.3	36.9	23.0	36.6	24.4	36.5	24.6	36.0	25.2	35.6	25.9	44
45	38.1	23.8	37.7	24.5	37.4	25.0	37.3	25.2	36.9	25.8	36.4	26.4	45
46	39.0	24.4	38.6	25.0	38.2	25.5	38.2	25.7	37.7	26.4	37.2	27.0	46
47	39.9	24.9	39.4	25.6	39.1	26.1	39.0	26.3	38.5	26.9	38.0	27.6	47
48	40.7	25.4	40.3	26.1	39.9	26.7	39.8	26.8	39.3	27.5	38.8	28.2	48
49	41.5	26.0	41.1	26.7	40.7	27.2	40.6	27.4	40.1	28.1	39.6	28.8	49
50	42.4	26.5	41.9	27.2	41.6	27.8	41.4	28.0	41.0	28.7	40.4	29.4	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	58 Deg.		57 Deg.		5 Points.		56 Deg.		55 Deg.		54 Deg.		

Dist.	32 Deg.		33 Deg.		3Points.		34 Deg.		35 Deg.		36 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	43.2	27.0	42.8	27.8	42.4	28.3	42.3	28.5	41.8	29.2	41.3	30.0	51
52	44.1	28.6	43.6	28.3	43.2	28.9	43.1	29.1	42.6	29.8	42.1	30.6	52
53	44.9	28.1	44.5	28.9	44.1	29.4	43.9	29.6	43.4	30.4	42.9	31.2	53
54	45.8	28.6	45.3	29.4	44.9	30.0	44.5	30.2	44.2	31.0	43.7	31.7	54
55	46.6	29.1	46.1	30.0	45.7	30.6	45.6	30.7	45.1	31.5	44.5	32.3	55
56	47.5	29.7	47.0	30.5	46.6	31.1	46.4	31.3	45.9	32.1	45.3	32.9	56
57	48.3	30.2	47.8	31.0	47.4	31.7	47.3	31.9	46.7	32.7	46.1	33.5	57
58	49.2	30.7	48.7	31.6	48.2	32.2	48.1	32.4	47.5	33.3	46.9	34.1	58
59	50.0	31.3	49.5	32.1	49.0	32.8	48.9	33.0	48.3	33.8	47.7	34.7	59
60	50.9	31.8	50.3	32.7	49.9	33.3	49.7	33.5	49.1	34.4	48.5	35.3	60
61	51.7	32.3	51.2	33.2	50.7	33.9	50.6	34.1	50.0	34.9	49.3	35.9	61
62	52.6	32.9	52.0	33.8	51.5	34.4	51.4	34.7	50.8	35.5	50.2	36.4	62
63	53.4	33.4	52.9	34.3	52.4	35.0	52.2	35.3	51.6	36.1	51.0	37.0	63
64	54.3	33.9	53.7	34.9	53.2	35.5	53.1	35.8	52.4	36.7	51.8	37.6	64
65	55.1	34.4	54.5	35.4	54.0	36.1	53.9	36.3	53.2	17.3	52.6	38.1	65
66	56.0	35.0	55.3	35.9	54.9	36.7	54.7	36.9	54.1	37.9	53.4	38.8	66
67	56.8	35.5	56.2	36.5	55.7	37.2	55.5	37.5	54.9	38.4	54.2	39.4	67
68	57.7	36.0	57.0	37.0	56.5	37.8	56.4	38.0	55.7	39.0	55.0	40.0	68
69	58.5	36.6	57.9	37.6	57.4	38.3	57.2	38.6	56.5	39.6	55.8	40.6	69
70	59.4	37.1	58.7	38.1	58.2	38.9	58.0	39.1	57.3	40.1	56.6	41.1	70
71	60.2	37.6	59.6	38.7	59.0	39.4	58.9	39.7	58.2	40.7	57.4	41.7	71
72	61.0	38.1	60.4	39.2	59.8	40.0	59.7	40.3	59.0	41.3	58.2	42.3	72
73	61.9	38.7	61.2	39.8	60.7	40.6	60.5	40.8	59.8	41.9	59.1	42.9	73
74	62.7	39.2	62.1	40.3	61.5	41.1	61.3	41.4	60.6	42.4	59.9	43.5	74
75	63.6	39.7	62.9	40.8	62.4	41.7	62.2	41.9	61.4	43.0	60.7	44.1	75
76	64.4	40.3	63.8	41.5	63.2	42.2	63.0	42.5	62.3	43.6	61.5	44.7	76
77	65.3	40.8	64.6	41.9	64.0	42.8	63.8	43.0	63.1	44.2	62.3	45.3	77
78	66.1	41.3	65.4	42.5	64.8	43.3	64.7	43.6	63.9	44.7	63.1	45.8	78
79	67.0	41.9	66.3	43.0	65.7	43.9	65.5	44.2	64.7	45.3	63.9	46.4	79
80	67.8	42.4	67.1	43.6	66.5	44.4	66.3	44.7	65.5	45.9	64.7	47.0	80
81	68.7	42.9	68.0	44.1	67.3	45.0	67.1	45.3	66.4	46.5	65.5	47.6	81
82	69.5	43.4	68.8	44.7	68.2	45.5	68.0	45.8	67.2	47.0	66.3	48.2	82
83	70.4	44.0	69.6	45.2	69.0	46.1	68.8	46.4	68.0	47.6	67.1	48.8	83
84	71.2	44.5	70.5	45.8	69.8	46.7	69.6	47.0	68.8	48.2	68.0	49.4	84
85	72.1	45.0	71.3	46.3	70.7	47.2	70.5	47.5	69.6	48.8	68.8	50.0	85
86	72.9	45.6	72.1	46.8	71.5	47.8	71.3	48.1	70.5	49.3	69.6	50.5	86
87	73.8	46.1	73.0	47.3	72.3	48.3	72.1	48.6	71.3	49.9	70.4	51.1	87
88	74.6	46.6	73.8	47.9	73.2	48.9	72.9	49.2	72.1	50.5	71.2	51.7	88
89	75.5	47.2	74.7	48.5	74.0	49.4	73.8	49.8	72.9	51.0	72.0	52.3	89
90	76.3	47.7	75.5	49.0	74.8	50.0	74.6	50.3	73.7	51.6	72.8	52.9	90
91	77.2	48.2	76.3	49.6	75.7	50.6	75.4	50.9	74.5	52.2	73.6	53.5	91
92	78.0	48.7	77.2	50.1	76.5	51.1	76.3	51.4	75.4	52.8	74.4	54.1	92
93	78.9	49.3	78.0	50.6	77.3	51.7	77.1	52.0	76.2	53.3	75.2	54.7	93
94	79.7	49.8	78.9	51.2	78.2	52.2	77.9	52.6	77.0	53.9	76.0	55.2	94
95	80.6	50.3	79.5	51.7	79.0	52.8	78.8	53.1	77.8	54.5	76.9	55.8	95
96	81.4	50.9	80.5	52.3	79.8	53.3	79.6	53.7	78.6	55.1	77.7	56.4	96
97	82.3	51.4	81.4	52.8	80.6	53.9	80.4	54.2	79.5	55.6	78.5	57.0	97
98	83.1	51.9	82.2	53.4	81.5	54.4	81.2	54.8	80.3	56.2	79.3	57.6	98
96	84.0	52.5	83.1	53.9	82.3	55.0	82.1	55.4	81.1	56.8	80.1	58.2	99
100	84.8	53.0	83.9	54.5	83.1	55.5	82.9	55.9	81.9	57.4	80.9	58.8	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	58 Deg.		57 Deg.		5Points.		56 Deg.		55 Deg.		54 Deg.		

Dist.	3¼ Point.		37 Deg.		38 Deg.		39 Deg.		3½ Point.		40 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.8	00.6	00.8	00.6	00.8	00.6	00.8	00.7	00.8	00.6	00.8	00.6	1
2	01.6	01.2	01.6	01.2	01.6	01.2	01.5	01.3	01.5	01.3	01.5	01.3	2
3	02.4	01.8	02.4	01.8	02.4	01.8	02.3	01.9	02.3	01.9	02.3	01.9	3
4	03.2	02.4	03.2	02.4	03.1	02.5	03.1	02.5	03.1	02.5	03.1	02.6	4
5	04.0	03.0	04.0	03.0	03.9	03.1	03.9	03.1	03.9	03.2	03.8	03.2	5
6	04.8	03.6	04.8	03.6	04.7	03.7	04.6	03.8	04.6	03.8	04.6	03.9	6
7	05.6	04.2	05.6	04.2	05.5	04.3	05.4	04.4	05.4	04.4	05.4	04.5	7
8	06.4	04.8	06.4	04.8	06.3	04.9	06.2	05.0	06.2	05.1	06.1	05.1	8
9	07.2	05.4	07.2	05.4	07.1	05.5	06.9	05.7	07.0	05.7	06.9	05.8	9
10	08.0	06.0	08.0	06.0	07.9	06.2	07.8	06.3	07.7	06.3	07.7	06.4	10
11	08.8	06.6	08.8	06.6	08.7	06.8	08.5	06.9	08.5	07.0	08.4	07.1	11
12	09.6	07.1	09.6	07.2	09.4	07.4	09.3	07.5	09.3	07.6	09.2	07.7	12
13	10.4	07.7	10.4	07.8	10.2	08.1	10.1	08.2	10.0	08.2	10.0	08.4	13
14	11.2	08.3	11.2	08.4	11.0	08.7	10.9	08.8	10.8	08.9	10.7	09.0	14
15	12.0	08.9	12.0	09.0	11.8	09.3	11.6	09.4	11.6	09.5	11.5	09.6	15
16	12.8	09.5	12.8	09.6	12.6	09.8	12.4	10.1	12.4	10.1	12.3	10.3	16
17	13.6	10.1	13.6	10.2	13.4	10.5	13.2	10.7	13.1	10.8	13.0	10.9	17
18	14.5	10.7	14.4	10.8	14.2	11.1	13.9	11.3	13.9	11.4	13.8	11.6	18
19	15.3	11.3	15.2	11.4	15.0	11.7	14.8	12.0	14.7	12.0	14.5	12.2	19
20	16.1	11.9	16.0	12.0	15.8	12.3	15.5	12.6	15.5	12.7	15.3	12.9	20
21	16.9	12.5	16.8	12.6	16.5	12.9	16.3	13.2	16.2	13.3	16.1	13.5	21
22	17.7	13.1	17.6	13.2	17.3	13.5	17.1	13.8	17.0	14.0	16.8	14.1	22
23	18.5	13.7	18.4	13.8	18.1	14.2	17.9	14.5	17.8	14.6	17.6	14.8	23
24	19.3	14.3	19.2	14.4	18.9	14.8	18.6	15.1	18.5	15.2	18.4	15.4	24
25	20.1	14.9	20.0	15.0	19.7	15.4	19.4	15.7	19.3	15.9	19.1	16.1	25
26	20.9	15.5	20.8	15.6	20.5	16.0	20.2	16.4	20.1	16.5	19.9	16.7	26
27	21.7	16.1	21.6	16.2	21.3	16.6	21.0	17.0	20.9	17.1	20.7	17.4	27
28	22.5	16.7	22.4	16.8	22.1	17.2	21.8	17.6	21.6	17.8	21.4	18.0	28
29	23.3	17.3	23.2	17.4	22.8	17.8	22.6	18.3	22.4	18.4	22.2	18.6	29
30	24.1	17.9	24.0	18.0	23.6	18.5	23.3	18.9	23.2	19.0	23.0	19.3	30
31	24.9	18.5	24.8	18.6	24.4	19.1	24.1	19.5	24.0	19.7	23.7	19.9	31
32	25.7	19.1	25.6	19.3	25.2	19.7	24.9	20.1	24.7	20.3	24.5	20.6	32
33	26.5	19.7	26.4	19.9	26.0	20.3	25.6	20.8	25.5	20.9	25.3	21.2	33
34	27.3	20.2	27.1	20.5	26.8	20.9	26.4	21.4	26.3	21.6	26.0	21.9	34
35	28.1	20.8	27.9	21.1	27.6	21.5	27.2	22.0	27.0	22.2	26.8	22.5	35
36	28.9	21.4	28.7	21.7	28.4	22.2	27.9	22.7	27.8	22.8	27.6	23.1	36
37	29.7	22.0	29.5	22.3	29.2	22.8	28.8	23.3	28.6	23.5	28.3	23.8	37
38	30.5	22.6	30.3	22.9	29.9	23.4	29.5	23.9	29.4	24.1	29.1	24.4	38
39	31.3	23.2	31.1	23.5	30.7	24.0	30.3	24.5	30.1	24.7	29.9	25.1	39
40	32.1	23.8	31.9	24.1	31.5	24.6	31.1	25.2	30.9	25.4	30.6	25.7	40
41	32.9	24.4	32.7	24.7	32.3	25.2	31.9	25.8	31.7	26.0	31.4	26.4	41
42	33.7	25.0	33.5	25.3	33.1	25.9	32.6	26.4	32.5	26.6	32.2	27.0	42
43	34.5	25.6	34.3	25.9	33.9	26.5	33.4	27.1	33.2	27.3	32.9	27.6	43
44	35.3	26.2	35.1	26.5	34.7	27.1	34.2	27.7	34.0	27.9	33.7	28.3	44
45	36.1	26.8	35.9	27.1	35.5	27.7	35.0	28.3	34.8	28.5	34.5	28.9	45
46	36.9	27.4	36.7	27.7	36.2	28.3	35.7	29.0	35.6	29.2	35.2	29.6	46
47	37.7	28.0	37.5	28.3	37.0	28.9	36.5	29.6	36.3	29.8	36.0	30.2	47
48	38.5	28.6	38.3	28.9	37.8	29.5	37.3	30.2	37.1	30.4	36.8	30.9	48
49	39.3	29.2	39.1	29.5	38.6	30.2	38.1	30.8	37.9	31.1	37.5	31.5	49
50	40.1	29.8	39.9	30.1	39.4	30.8	38.9	31.5	38.6	31.7	38.3	32.1	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	4¾ Point.		53 Deg.		52 Deg.		51 Deg.		4½ Point.		50 Deg.		

Dist.	3¼ *Point.*		37 Deg.		38 Deg.		39 Deg.		3½ *Point.*		40 Deg.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	41.0	30.4	40.7	30.7	40.2	31.4	39.6	32.1	39.4	32.3	39.1	32.8	51
52	41.8	31.0	41.5	31.3	41.0	32.0	40.4	32.7	40.2	33.0	39.8	33.4	52
53	42.6	31.6	42.3	31.9	41.8	32.6	41.2	33.3	41.0	33.6	40.6	34.1	53
54	43.4	32.2	43.1	32.5	42.5	33.2	42.0	34.0	41.7	34.3	41.4	34.7	54
55	44.2	32.8	43.9	33.1	43.3	33.9	42.7	34.6	42.5	34.9	42.1	35.4	55
56	45.0	33.3	44.7	33.7	44.1	34.5	43.5	35.2	43.3	35.5	42.9	36.0	56
57	45.8	33.9	45.5	34.3	44.9	35.1	44.3	35.9	44.1	36.2	43.7	36.6	57
58	46.6	34.5	46.3	34.9	45.7	35.8	45.1	36.5	44.8	36.8	44.4	37.3	58
59	47.4	35.1	47.1	35.5	46.5	36.3	45.8	37.1	45.6	37.4	45.2	37.9	59
60	48.2	35.7	47.9	36.1	47.3	36.9	46.6	37.8	46.4	38.1	46.0	38.6	60
61	49.0	36.3	48.7	36.7	48.1	37.5	47.4	38.4	47.1	38.7	46.7	39.3	61
62	49.8	36.9	49.5	37.3	48.9	38.2	48.2	39.0	47.9	39.3	47.5	39.9	62
63	50.6	37.5	50.3	37.9	49.6	38.8	49.0	39.6	48.7	40.0	48.3	40.5	63
64	51.4	38.1	51.1	38.5	50.4	39.4	49.7	40.3	49.5	40.6	49.0	41.2	64
65	52.2	38.7	51.9	39.1	51.2	40.0	50.5	40.9	50.2	41.2	49.8	41.8	65
66	53.0	39.3	52.7	39.7	52.0	40.6	51.3	41.5	51.0	41.9	50.6	42.4	66
67	53.8	39.9	53.5	40.3	52.8	41.2	52.1	42.2	51.8	42.5	51.3	43.1	67
68	54.6	40.5	54.3	40.9	53.6	41.9	52.8	42.8	52.6	43.1	52.1	43.7	68
69	55.4	41.1	55.1	41.5	54.4	42.5	53.6	43.4	53.3	43.8	52.9	44.4	69
70	56.2	41.7	55.9	42.1	55.2	43.1	54.4	44.0	54.1	44.4	53.6	45.0	70
71	57.0	42.3	56.7	42.7	55.9	43.7	55.2	44.7	54.9	45.0	54.4	45.6	71
72	57.8	42.9	57.5	43.3	56.7	44.3	55.9	45.3	55.7	45.7	55.1	46.3	72
73	58.6	43.5	58.3	43.9	57.5	44.9	56.7	45.9	56.4	46.3	55.9	46.9	73
74	59.4	44.1	59.1	44.5	58.3	45.6	57.5	46.6	57.2	46.9	56.7	47.0	74
75	60.2	44.7	59.9	45.1	59.2	46.2	58.3	47.2	58.0	47.6	57.4	48.2	75
76	61.0	45.3	60.7	45.7	60.0	46.8	59.5	47.8	58.7	48.2	58.2	48.9	76
77	61.8	45.9	61.5	46.3	60.7	47.4	59.8	48.5	59.5	48.8	59.0	49.5	77
78	62.7	46.5	62.3	46.9	61.5	48.0	60.6	49.1	60.3	49.5	59.7	50.1	78
79	63.5	47.1	63.1	47.5	62.2	48.6	61.4	49.7	61.1	50.1	60.5	50.8	79
80	64.3	47.7	63.9	48.1	63.0	49.3	62.2	50.3	61.8	50.7	61.3	51.4	80
81	65.1	48.3	64.7	48.7	63.8	49.9	62.9	51.0	62.6	51.4	62.0	52.1	81
82	65.9	48.8	65.5	49.3	64.6	50.5	63.7	51.6	63.4	52.0	62.8	52.7	82
83	66.7	49.4	66.3	49.9	65.4	51.1	64.5	52.2	64.2	52.6	63.6	53.4	83
84	67.5	50.0	67.1	50.5	66.2	51.7	65.3	52.9	64.9	53.3	64.3	54.0	84
85	68.3	50.6	67.9	51.1	67.0	52.3	66.1	53.5	65.7	53.9	65.1	54.6	85
86	69.1	51.2	68.7	51.7	67.8	52.9	66.8	54.1	66.5	54.6	65.9	55.3	86
87	69.9	51.8	69.5	52.4	68.6	53.6	67.6	54.8	67.2	55.2	66.6	55.9	87
88	70.7	52.4	70.3	53.0	69.3	54.2	68.4	55.4	68.0	55.8	67.4	56.6	88
89	71.5	53.0	71.1	53.6	70.1	54.8	69.2	56.0	68.8	56.5	68.2	57.2	89
90	72.3	53.6	71.9	54.2	70.9	55.4	69.9	56.6	69.6	57.1	68.9	57.8	90
91	73.1	54.2	72.7	54.8	71.7	56.0	70.7	57.3	70.3	57.7	69.7	58.5	91
92	73.9	54.8	73.5	55.4	72.5	56.6	71.5	57.9	71.1	58.4	70.5	59.1	92
93	74.7	55.4	74.3	56.0	73.3	57.3	72.3	58.5	71.9	59.0	71.2	59.8	93
94	75.5	56.0	75.1	56.6	74.1	57.9	73.0	59.2	72.7	59.6	72.0	60.4	94
95	76.3	56.6	75.9	57.2	74.9	58.5	73.8	59.8	73.4	60.3	72.8	61.1	95
96	77.1	57.2	76.7	57.8	75.6	59.1	74.6	60.4	74.2	60.9	73.5	61.7	96
97	77.9	57.8	77.5	58.4	76.4	59.7	75.4	61.0	75.0	61.5	74.3	62.4	97
98	78.7	58.4	78.3	59.0	77.2	60.3	76.2	61.7	75.7	62.2	75.1	63.0	98
99	79.5	59.0	79.1	59.6	78.0	60.9	76.9	62.3	76.5	62.8	75.8	63.6	99
100	80.3	59.6	79.9	60.2	78.8	61.6	77.7	62.9	77.3	63.4	76.6	64.3	100
	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	
Dist.	4¾ *Point.*		53 Deg.		52 Deg.		51 Deg.		4½ *Point.*		50 Deg.		Dist.

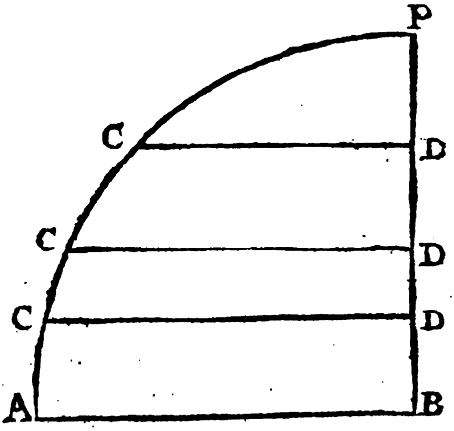
Diff.	41 Deg.		42 Deg.		3¾ *Point.*		43 Deg.		44 Deg.		4 Points.		Diff.
	Lat.	Dep.	Lat.	Dep.	Dep.	Lat.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	00.7	00.7	00.7	00.7	00.7	00.7	00.7	00.7	00.7	00.7	00.7	00.7	1
2	01.5	01.3	01.5	01.3	01.5	01.3	01.5	01.4	01.4	01.4	01.4	01.4	2
3	02.3	02.0	02.2	02.0	02.2	02.0	01.2	02.0	02.2	02.1	02.1	02.1	3
4	03.0	02.6	03.0	02.7	03.0	02.7	02.9	02.7	02.9	02.8	02.8	02.8	4
5	03.8	03.3	03.7	03.3	03.7	03.4	03.6	03.4	03.6	03.5	03.5	03.5	5
6	04.5	03.9	04.5	04.0	04.4	04.0	04.4	04.1	04.3	04.2	04.2	04.2	6
7	05.3	04.6	05.2	04.7	05.2	04.7	05.1	04.8	05.0	04.9	04.9	04.9	7
8	06.0	05.2	05.9	05.3	05.9	05.4	05.8	05.5	05.7	05.6	05.7	05.7	8
9	06.8	05.9	06.7	06.0	06.7	06.0	06.6	06.1	06.5	06.2	06.4	06.4	9
10	07.5	06.6	07.4	06.7	07.4	06.7	07.3	06.8	07.2	06.9	07.1	07.1	10
11	08.3	07.2	08.2	07.4	08.1	07.4	08.0	07.5	07.9	07.6	07.8	07.8	11
12	09.1	07.9	08.9	08.0	08.9	08.1	08.8	08.2	08.6	08.3	08.5	08.5	12
13	09.8	08.5	09.7	08.7	09.6	08.7	09.5	08.9	09.3	09.0	09.2	09.2	13
14	10.6	09.2	10.4	09.4	10.4	09.4	10.2	09.5	10.1	09.7	09.9	09.9	14
15	11.3	09.8	11.1	10.0	11.1	10.1	11.0	10.2	10.8	10.4	10.6	10.6	15
16	12.1	10.5	11.9	10.7	11.9	10.7	11.7	10.9	11.5	11.1	11.3	11.3	16
17	12.8	11.1	12.6	11.4	12.6	11.4	12.4	11.6	12.2	11.8	12.0	12.0	17
18	13.6	11.8	13.4	12.0	13.3	12.1	13.2	12.3	12.9	12.5	12.7	12.7	18
19	14.3	12.5	14.1	12.7	14.1	12.8	13.9	13.0	13.7	13.2	13.4	13.4	19
20	15.1	13.2	14.9	13.4	14.8	13.4	14.6	13.6	14.4	13.9	14.1	14.1	20
21	15.8	13.8	15.6	14.0	15.6	14.1	15.4	14.3	15.1	14.6	14.8	14.8	21
22	16.6	14.4	16.3	14.7	16.3	14.8	16.1	15.0	15.8	15.3	15.5	15.5	22
23	17.4	15.1	17.1	15.4	17.0	15.4	16.8	15.7	16.5	16.0	16.3	16.3	23
24	18.1	15.7	17.8	16.1	17.8	16.1	17.5	16.4	17.3	16.7	17.0	17.0	24
25	18.9	16.4	18.6	16.7	18.5	16.8	18.3	17.1	18.0	17.4	17.7	17.7	25
26	19.6	17.1	19.3	17.5	19.3	17.4	19.0	17.7	18.7	18.1	18.4	18.4	26
27	20.4	17.7	20.1	18.1	20.0	18.1	19.2	18.4	19.4	18.8	19.1	19.1	27
28	21.1	18.4	20.8	18.7	20.7	18.8	20.5	19.1	20.1	19.4	19.8	19.8	28
29	21.9	19.0	21.5	19.4	21.5	19.5	21.2	19.8	20.9	20.1	20.5	20.5	29
30	22.6	19.7	22.3	20.1	22.2	20.1	21.9	20.5	21.6	20.8	21.2	21.2	30
31	23.4	20.3	23.0	20.7	23.0	20.8	22.6	21.1	22.3	21.5	21.9	21.9	31
32	24.1	21.0	23.8	21.4	23.7	21.5	23.4	21.8	23.0	22.2	22.6	22.6	32
33	24.9	21.6	24.5	22.1	24.4	22.2	24.1	22.5	23.7	22.9	23.3	23.3	33
34	25.6	22.3	25.3	22.7	25.2	22.8	24.9	23.2	24.5	23.6	24.0	24.0	34
35	26.4	23.0	26.0	23.4	25.9	23.5	25.6	23.9	25.2	24.3	24.7	24.7	35
36	27.2	23.6	26.7	24.1	26.7	24.2	26.3	24.5	25.9	25.0	25.4	25.4	36
37	27.9	24.3	27.5	24.7	27.4	24.8	27.0	25.2	26.6	25.7	26.1	26.1	37
38	28.7	24.9	28.2	25.4	28.2	25.5	27.8	25.9	27.3	26.4	26.9	26.9	38
39	29.4	25.6	29.0	26.1	28.9	26.2	28.5	26.6	28.0	27.1	27.6	27.6	39
40	30.2	26.2	29.7	26.8	29.6	26.9	29.2	27.3	28.8	27.8	28.3	28.3	40
41	31.0	26.9	30.5	27.4	30.4	27.5	30.0	28.0	29.5	28.5	29.0	29.0	41
42	31.7	27.5	31.2	28.1	31.1	28.2	30.7	28.6	30.2	29.2	29.7	29.7	42
43	32.5	28.2	31.9	28.8	31.9	28.9	31.4	29.3	30.9	29.9	30.4	30.4	43
44	33.2	28.9	32.7	29.4	32.6	29.5	32.2	30.0	31.6	30.6	31.1	31.1	44
45	34.0	29.5	33.4	30.1	33.3	30.2	32.9	30.7	32.4	31.3	31.8	31.8	45
46	34.7	30.2	34.2	30.8	34.1	30.9	33.6	31.4	33.1	32.0	32.5	32.5	46
47	35.5	30.8	34.9	31.4	34.8	31.6	34.4	32.1	33.8	32.6	33.2	33.2	47
48	36.3	31.5	35.7	32.1	35.6	32.2	35.1	32.7	34.5	33.3	33.9	33.9	48
49	37.0	32.1	36.4	32.8	36.3	33.9	35.8	33.4	35.2	34.0	34.6	34.6	49
50	37.7	32.8	37.2	33.5	37.0	33.6	36.6	4.1	36.0	34.7	35.3	35.3	50
Diff.	Dep.	Lat.	Dep.	Lat.	Lat.	Dep.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Diff.
	49 Deg.		48 Deg.		4¼ *Point.*		47 Deg.		46 Deg.		4 Points.		

Dist.	41 Deg.		42 Deg.		3¾ *Point.*		43 Deg.		44 Deg.		4Points.		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
51	38.5	33.5	37.9	34.1	37.8	34.2	37.3	34.8	36.7	35.4	36.1	36.1	51
52	39.2	34.1	38.6	34.8	38.5	34.9	38.0	35.5	37.4	36.1	36.8	36.8	52
53	40.0	34.8	39.4	35.5	39.3	35.6	38.8	36.1	38.1	36.8	37.5	37.5	53
54	40.8	35.4	40.1	36.1	40.0	36.3	39.5	36.8	38.8	37.5	38.2	38.2	54
55	41.5	36.0	40.9	36.8	40.7	36.9	40.2	37.5	39.6	38.2	38.9	38.9	55
56	42.3	36.7	41.6	37.5	41.5	37.6	41.0	38.2	40.3	38.9	39.6	39.6	56
57	43.0	37.4	42.4	38.1	42.2	38.3	41.7	38.9	41.0	39.9	40.3	40.3	57
58	43.8	38.1	43.1	38.8	43.0	38.9	42.4	39.5	41.7	40.3	41.0	41.0	58
59	44.5	38.7	43.8	39.5	43.7	39.6	43.1	40.2	42.4	41.0	41.7	41.7	59
60	45.3	39.4	44.6	40.1	44.5	40.3	43.8	40.9	43.2	41.7	42.4	42.4	60
61	46.0	40.0	45.3	40.8	45.2	41.0	44.6	41.7	43.9	42.4	43.1	43.1	61
62	46.8	40.7	46.1	41.5	45.9	41.6	45.3	42.3	44.6	43.1	43.8	43.8	62
63	47.6	41.3	46.8	42.2	46.7	42.3	46.1	43.0	45.3	43.8	44.5	44.5	63
64	48.3	42.0	47.5	42.8	47.4	43.0	46.8	43.6	46.0	44.5	45.3	45.3	64
65	49.1	42.6	48.3	43.5	48.2	43.6	47.5	44.3	46.8	45.1	46.0	46.0	65
66	49.8	43.3	49.0	44.2	48.9	44.3	48.3	45.0	47.5	45.8	46.7	46.7	66
67	50.6	44.0	49.8	44.8	49.6	45.0	49.0	45.7	48.2	46.5	47.4	47.4	67
68	51.3	44.6	50.5	45.5	50.4	45.7	49.7	46.4	48.9	47.2	48.1	48.1	68
69	52.1	45.3	51.3	46.2	51.1	46.3	50.5	47.1	49.6	47.9	48.8	48.8	69
70	52.8	45.9	52.0	46.8	51.9	47.0	51.2	47.7	50.3	48.6	49.5	49.5	70
71	53.6	46.6	52.8	47.5	52.6	47.7	51.9	48.4	51.1	49.3	50.2	50.2	71
72	54.3	47.2	53.5	48.2	53.3	48.3	52.7	49.1	51.8	50.0	50.9	50.9	72
73	55.1	47.9	54.2	48.8	54.1	49.0	53.4	49.8	52.5	50.7	51.6	51.6	73
74	55.9	48.5	55.0	49.5	54.8	49.7	54.1	50.5	53.2	51.4	52.3	52.3	74
75	56.6	49.2	55.7	50.2	55.6	50.4	54.8	51.1	53.9	52.1	53.0	53.0	75
76	57.4	49.9	56.5	50.9	56.3	51.0	55.6	51.8	54.7	52.8	53.7	53.7	76
77	58.1	50.5	57.2	51.5	57.1	51.7	56.3	52.5	55.4	53.5	54.4	54.4	77
78	58.9	51.2	58.0	52.1	57.8	52.4	57.0	53.2	56.1	54.2	55.2	55.2	78
79	59.6	51.8	58.7	52.8	58.5	53.0	57.8	53.9	56.8	54.9	55.9	55.9	79
80	60.4	52.5	59.4	53.5	59.3	53.7	58.5	54.6	57.5	55.6	56.6	56.6	80
81	61.1	53.1	60.2	54.2	60.0	54.4	59.2	55.4	58.3	56.3	57.3	57.3	81
82	61.9	53.8	60.9	54.9	60.8	55.1	60.0	55.9	59.0	57.0	58.0	58.0	82
83	62.6	54.5	61.7	55.5	61.5	55.7	60.7	56.6	59.7	57.6	58.7	58.7	83
84	63.4	55.1	62.4	56.2	62.2	56.4	61.4	57.3	60.4	58.3	59.4	59.4	84
85	64.2	55.9	63.2	56.9	63.0	57.1	62.2	58.0	61.1	59.0	60.1	60.1	85
86	64.9	56.4	63.9	57.5	63.7	57.7	63.0	58.6	61.9	59.7	60.8	60.8	86
87	65.7	57.1	64.7	58.2	64.5	58.4	63.6	59.3	62.6	60.4	61.5	61.5	87
88	66.4	57.7	65.4	58.9	65.2	59.1	64.4	60.0	63.3	61.1	62.2	62.2	88
89	67.2	58.4	66.1	59.6	65.9	59.8	65.1	60.7	64.0	61.8	62.9	62.9	89
90	67.9	59.1	66.9	60.2	66.7	60.4	65.8	61.4	64.7	62.5	63.6	63.6	90
91	68.7	59.7	67.6	60.9	67.4	61.1	66.5	62.1	65.5	63.2	64.3	64.3	91
92	69.4	60.4	68.4	61.6	68.2	61.8	67.3	62.7	66.2	63.9	65.0	65.0	92
93	70.2	61.0	69.1	62.2	68.9	62.4	68.0	63.4	66.9	64.6	65.8	65.8	93
94	71.0	61.7	69.9	62.9	69.6	63.1	68.7	64.1	67.6	65.3	66.5	66.5	94
95	71.7	62.3	70.6	63.6	70.4	63.8	69.5	64.8	68.3	66.0	67.2	67.2	95
96	72.5	63.0	71.3	64.2	71.1	64.5	70.2	65.5	69.1	66.7	67.9	67.9	96
97	73.2	63.6	72.1	64.9	71.9	65.1	70.9	66.1	69.8	67.4	68.6	68.6	97
98	74.0	64.3	72.8	65.6	72.6	65.8	71.7	66.8	70.5	68.1	69.3	69.3	98
99	74.7	65.0	73.6	66.2	73.4	66.5	72.4	67.5	71.2	68.8	70.0	70.0	99
100	75.5	61.6	74.3	66.0	74.1	67.2	73.1	68.2	71.9	69.5	70.7	70.7	100
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	49 Deg.		48 Deg.		4¼ *Point.*		47 Deg.		46 Deg.		4Points.		

SECT. VIII.

Of PARALLEL SAILING.

1. SINCE the *Parallels of Latitude* do always decreaſe as they approach the *Pole*, it is plain a Degree on any Parallel muſt be leſs than a Degree upon the *Equator*. Now in order to know the Length of a Degree on any given Parallel of Latitude, let PB repreſent half the Earth's Axis, PA a Quadrant of a *Meridian*, and conſequently A a Point on the *Equator*, C a Point on the *Meridian*, and CD a Perpendicular from that Point upon the Axis, which will be the Sine of the Arch CP, the Diſtance of that Point from the Pole, or the Coſine of CA it's Diſtance from the Equator, and CD will be to AB as the Sine of CP, or Coſine of CA, is to the Radius. Again, if the Quadrant PAB be turned round upon the Axis PB, the



the Point A will deſcribe the Circumference of the *Equator*, whoſe Radius is A B, and any other Point C upon the Meridian, will deſcribe the Circumference of a *Parallel* to the Radius C D.

Cor. 1. Hence (becauſe the Circumferences of Circles are as their *Radii*, by *Art.* 74. *Sect.* 1.) it follows that the Circumference of any *Parallel* is to the Circumference of the *Equator*, as the Co-ſine of it's Latitude is to Radius.

Cor. 2. And ſince the Wholes are as their ſimilar aliquot Parts, it will be as the Length of a Degree on any *Parallel* is to the Length of a Degree upon the *Equator*, ſo is the Co-ſine of the Latitude of that *Parallel* to Radius.

Cor. 3. Hence as Radius is to the Co-ſine of any Latitude, ſo are the Minutes of Difference of Longitude between two *Meridians*, or their Diſtance in Miles upon the Equator, to the Diſtance of thoſe Meridians on that *Parallel* in Miles.

Cor. 4. And as the Co-ſine of any *Parallel* is to Radius, ſo is the Length of any Arch on that *Parallel* (intercepted between two *Meridians*) in Miles, to the Length of a ſimilar Arch on the *Equator*, or Minutes of Difference of Longitude.

Cor. 5. Alſo as the Co-ſine of any one *Parallel* is to the Co-ſine of any other *Parallel*, ſo is the Length of any Arch on the firſt, in Miles, to the Length of the ſame Arch on the other in Miles.

2 From what has been ſaid, ariſes the Solution of the ſeveral Caſes of *Parallel Sailing*, which are as follow:

CASE 1.

Given the Difference of Longitude between two Places, both lying on the ſame Parallel, *to find the Diſtance between thoſe Places.*

Example 1.

Suppoſe a Ship in the Latitude of 54°, 20′ North, ſails directly Weſt on that *Parallel*, 'till ſhe has differed her Longitude 12°, 45′; required the Diſtance ſailed on that *Parallel*.

Firſt, The Difference of Longitude reduced into Minutes, or nautical Miles, is 765′, which is the Diſtance between the Meridian ſailed from, and the Meridian come to, upon the *Equator*; then to find the Diſtance between theſe Meridians on the *Parallel* of 54°, 20′, or the Diſtance ſailed, it will be, by *Cor.* 3. of the laſt *Article*,

As Radius - - - - - - - - - - - 10.00000
is to the Co-ſine of the Lat. - 54°, 20′ - 9.76572
ſo are the Minutes of Diff. Long. - 765 - 2.88366
to the Diſtance on the Parallel - 446.1 - 2.64938

Example 2.

A Degree on the *Equator* being 60 Minutes, or nautical Miles; required the Length of a Degree on the *Parallel* of 51°, 32′.

By *Cor.* 3. of the laſt *Article*, it will be

As Radius - - - - - - - - - - - 10.00000
is to the Co-ſine of the Lat. - 51°, 32′ 9.79383
ſo are the Min. in 1 Deg. on the *Equa.* 60 - 1.77815
to - - - - - - - - - - - 37.32 - 1.57198
the Miles anſwering to a Degree on the *Parallel* of 51°, 32′.

By this *Problem* the following Table is conſtructed, ſhewing the Geographic Miles anſwering to a Degree on any *Parallel* of Latitude; in which you may obſerve, that the Columns marked at the Top with *D. L.* contain the Degree of Latitude belonging to each *Parallel*; and the adjacent Columns marked at the Top *Miles*, contain the Geographic Miles anſwering to a Degree upon theſe *Parallels*.

A Table *ſhewing how many Miles anſwer to a Degree of* Longitude, *at every Degree of* Latitude.

D.L.	*Miles.*	*D.L.*	*Miles.*	*D.L.*	*Miles.*	*D.L.*	*Miles.*	*D.L.*	*Miles.*
1	59.99	19	56.73	37	47.92	55	34.41	73	17.54
2	59.97	20	56.38	38	47.28	56	33.55	74	16.53
3	59.92	21	56.01	39	46.62	57	32.68	75	15.52
4	59.86	22	55.63	40	45.95	58	31.79	76	14.51
5	59.77	23	55.23	41	45.28	59	30.90	77	13.50
6	59.67	24	54.81	42	44.59	60	30.00	78	12.48
7	59.56	25	54.38	43	43.88	61	29.09	79	11.45
8	59.42	26	53.93	44	43.16	62	28.17	80	10.42
9	59.26	27	53.46	45	42.43	63	27.24	81	9.38
10	59.08	28	52.97	46	41.68	64	26.30	82	8.35
11	58.89	29	52.47	47	40.92	65	25.36	83	7.32
12	58.68	30	51.96	48	40.15	66	24.41	84	6.28
13	58.46	31	51.43	49	39.36	67	23.45	85	5.23
14	58.22	32	50.88	50	38.57	68	22.48	86	4.18
15	57.95	33	50.32	51	37.76	69	21.50	87	3.14
16	57.67	34	49.74	52	36.94	70	20.52	88	2.09
17	57.37	35	49.15	53	36.11	71	19.54	89	1.05
18	57.06	36	48.54	54	35.26	72	18.55	90	0.00

Though this Table only ſhews the Miles anſwering to a Degree of any *Parallel*, whoſe Latitude conſiſts of a whole Number of Degrees, yet it may be made to ſerve for any *Parallel*, whoſe Latitude is ſome Number of Degrees and Minutes, by making the following Proportion, *viz.*

As 1 Degree, or 60 Minutes, is to the Difference between the Miles anſwering to a Degree in the next greater and next leſs Tabular Latitude than that propoſed, ſo is the Exceſs of the propoſed Latitude above the next tabular Latitude, to a a proportional Part; which, ſubtracted from the Miles anſwering to a Degree of Longitude in the next leſs tabular Latitude, will give the Miles anſwering to a Degree in the propoſed Latitude.

Example.

Required to find the Miles anſwering to a Degree on the *Parallel* of 56°, 44′.

Firſt, The next leſs *Parallel* of Latitude in the Table than that propoſed, is that of 56°, a Degree of which (by the Table) is equal to 33.55 Miles; and the next greater *Parallel* of Latitude in the Table than that propoſed, is that of 57°, a Degree of which is (by the Table) equal to 32.68 Miles; the Difference of theſe is .87, and the Diſtance between theſe *Parallels* is 1 Degree, or 60 Minutes; alſo the Diſtance between the *Parallel* of 56°, and the propoſed *Parallel* of 56°, 44′, is 44 Minutes; then by the preceding Proportion it will be, As 60 is to .87, ſo is 44 to .638, the Difference between a Degree on the *Parallel* of 56°, and a Degree on the *Parallel* of 56°, 44′, which therefore taken from 33.55, the Miles anſwering to a Degree on the *Parallel* of 56°, leaves 32.912, the Miles anſwering to a Degree on the *Parallel* of 56°, 44′, as was required.

CASE 2.

The Diſtance ſailed in any Parallel *of Latitude, or the Diſtance between any two Places on that* Parallel *being given, to find the Difference of Longitude.*

Example.

Suppoſe a Ship in the Latitude of 55°, 36′ North, ſails directly Eaſt 685.6 Miles; required how much ſhe has differed her Longitude.

By *Cor.* 4. *Art.* 1. of this *Section*, it will be

As the Co-ſine of the Lat. - 55°, 36′ - 9.75202
is to the Radius - - - - - - - 10.00000
ſo is the Diſtance ſailed - 685.6 - - 2.83607
to Min. of Diff. of Long. - 1213 - - 3.08405
which reduced into Degrees, by dividing by 60, makes 20°, 13′, the Difference of Longitude the Ship has made.

This may alſo be ſolved by Help of the foregoing Table, *viz.* by finding from it the Miles anſwering to a Degree on the propoſed *Parallel*, and dividing with this the given Number of Miles, the Quotient will be the Degrees and Minutes of Difference of Longitude required.

Thus in the laſt *Example*, I find, from the foregoing Table, that a Degree on the *Parallel* of 55°, 36′, is equal to 33.89 Miles; by this I divide the propoſed Number of Miles 685.6, and the Quotient is 20.23 Degrees, *i. e.* 20°, 23′, 8 the Difference of Longitude required.

CASE 3.

The Difference of Longitude between two Places on the ſame Parallel, *and the Diſtance between them being given, to find the Latitude of that* Parallel.

Example.

Suppoſe a Ship ſails on a certain *Parallel* directly Weſt 624 Miles, and then has differed her Longitude 18°, 46′, or 1126 Miles; required the Latitude of the *Parallel* ſhe ſailed upon.

By *Cor.* 3. *Art.* 1. of this *Section*, it will be

As the Min. of Diff. of Long.	1126	3.05154
is to the Diſtance ſailed	624	2.79518
ſo is Radius		10.00000
to the Co-Sine of the Lat.	56°, 21′	9.74364

conſequently the Latitude of the Ship, or *Parallel* ſhe ſailed upon, was 56°, 21′.

From what has been ſaid, may be ſolved the following Problems.

PROB 1.

Suppoſe two Ships in the Latitude of 46°, 30′, North, diſtant aſunder 654 Miles, ſail both directly North 256 Miles, and conſequently are come to the Latitude of 50°, 46′, North; required their Diſtance on that *Parallel*.

By *Cor.* 5. *Art.* 1. of this *Section*, it will be

As the Co-ſine of	46°, 33′	9.83741
is to the Co-ſine of	50°, 46′	9.80105
ſo is	654	2.81558
to	601.4	2.77922

the Diſtance between the Ships when on the *Parallel* of 50°, 46′.

PROB. 2.

Suppoſe two Ships in the Latitude of 45°, 48′ North, diſtant 846 Miles, ſail directly North 'till the Diſtance between them is 624 Miles; required the Latitude come to, and the Diſtance ſailed.

By *Cor.* 5. *Art.* 1. of this *Section*, it will be

As their firſt Diſtance - - 846 - - 2.92737
is to their ſecond Diſtance - 624 - - 2.79518
ſo is the Co-ſine of - - 45°, 48′ - 9.84334
to the Co-ſine - - - - 59 , 04 - 9.71115

Conſequently to find their Diſtance ſailed,

From the Latitude come to - - - - 59°, 04′
ſubtract the Latitude ſailed from - - 45 , 48

and there remains - - - - - - - 13 , 16

equal to 796 Miles, the Difference of Latitude or Diſtance ſailed.

3. Though in ſolving the Problems in this Section, we ſuppoſed the Earth to be really ſpherical, yet it is not ſo, but rather an *oblate Spheriod*, having the Diameter of the Equator about 34 Miles longer than the Axis; which makes the Length of a Degree on the Meridian, near the Poles, about a Mile longer than the Length of a Degree near the Equator; and the *Radii* of the *Parallels*, inſtead of being Sines in a Circle, will be *Ordinates* to the leſſer Axe of an *Ellipſe*. Conſequently the true Length of a Degree on any *Parallel* will ſomewhat differ from it's Length, on the Suppoſition of the Earth's being a Sphere; but this Difference is ſo ſmall, that in all *nautical* Caſes it may ſafely be neglected.

SECT. IX.

Of Middle Latitude Sailing.

1. WHEN two Places lie both on the ſame *Parallel*, we ſhewed, in the laſt Section, how from the Difference of Longitude given, to find the Miles of Eaſting or Weſting between them, *& è contra*; but when two Places lie not on the ſame *Parallel*, then their Difference of Longitude cannot be reduced to Miles of Eaſting or Weſting on the *Parallel* of either Place; for if counted on the *Parallel* of that Place that has the greateſt Latitude, it would be too ſmall; and if on the *Parallel* of that Place having the leaſt Latitude, it would be too great. Hence the common Way of reducing the Difference of Longitude between two Places, lying on different Parallels, to Miles of Eaſting or Weſting, *& è contra*, is by counting it on the middle *Parallel* between the Places, which is found by adding the Latitudes of the two Places together, and taking Half the Sum, which will be the Latitude of the middle *Parallel* required. And hence ariſes the Solution of the following Caſes.

CASE 1.

The Latitudes of two Places, and their Difference of Longitude given, to find the direct Courſe and Diſtance.

Example.

Required the direct Courſe and Diſtance between the *Lizard*, in the Latitude of 50°, 00′ North, and

Longitude of 50°, 14′ W. and *St. Vincent* in the Latitude of 17°, 10′ N. and Longitude of 24°, 20′ W.

Firſt, To the Latitude of the *Lizard* -	50°, 00′ N.
add the Latitude of *St. Vincent* - -	17 , 10 N.
The Sum is - - - - - - - - -	67°, 10′
Half the Sum, or Latitude of the middle *Parallel* - -	- 33 , 35 N.
Alſo the Difference of Latitude is -	32 , 50

equal to 1970 Miles of Southing. Again,

From the Longitude of *St. Vincent* -	20°, 20′ W.
take the Longitude of the *Lizard* -	05 , 14
there remains - - - - - - -	19 , 06

equal to 1146 *Min.* of Diff. of Long. Weſt.

Then for the Miles of Weſting, or Departure, it will be, by *Caſe* 1. of *Parallel Sailing*,

As Radius - - - - - - - - - -		10.00000
is to the Co-ſine of the middle Parallel -	33°, 35′ -	9.92069
ſo is Min. Diff. of Long. -	1146 - -	3.05918
to the Miles of Weſting -	954.7 -	2.97987

And for the Courſe it will be, by *Caſe* 4. *of Plane Sailing*,

As the Diff. of Lat. - -	1970 - -	3.29447
is to Radius - - - - - - - - - -		10.00000
ſo is the Departure - -	954.7 - -	2.97987
to the Tang. of the Courſe	25°, 51′ -	9.68540

which, becauſe it is between South and Weſt, will be S S W ½ Weſt nearly.

For the Diſtance it will be, by the ſame *Caſe*,

As Radius - - - - - - - - - -		10.00000
is to the Diff. of Lat. -	1970 - - -	3.29447

ſo is the Secant of the Courſe	25°, 51′	10.04579
to the Diſtance		3.34026

whence the direct Courſe and Diſtance from the *Lizard* to *St. Vincent*, is S S W ¼ W. 2189 Miles.

CASE 2

One Latitude, Courſe, and Diſtance ſailed, being given, to find the other Latitude and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 50°, 00′ North, ſails South 50°, 06′ Weſt 150 Miles; required the Latitude the Ship has come to, and how much ſhe has differed her Longitude.

First, For the Difference of Latitude it will be, by *Caſe* 1. *of Plane Sailing*,

As Radius		10.00000
is to the Diſtance	150	2.17609
ſo is the Co-ſine of the Courſe	50°, 06′,	9.80716
to the Diff. of Latitude	96.22	1.98325

equal to 1°, 36′: And ſince the Ship is ſailing towards the Equator, therefore,

From the Latitude ſhe was in	50°, 00′ N.
take the Difference of Latitude	1°, 36′ S.
and there remains	48°, 24′ N.

the Latitude ſhe has come to North. Conſequently the Latitude of the middle *Parallel* will be 49°, 12′.

Then for Departure or Weſting it will be, by the ſame *Caſe*,

As Radius		10.00000
is to the Diſtance	150	2.17609
ſo is the Sine of the Courſe	50°, 06′	9.88489
to the Departure	115.1	2.06098

and for the Difference of Longitude it will be, by *Caſe* 2. *of Plane Sailing*,

As the Co-ſine of the middle *Parallel*	49°, 12′	9.81519
is to Radius		10.00000
ſo is the Departure	115.1	2.06098
to the min. Diff. of Longitude	176.1	2.24579

equal to 2°, 56′, which is the Difference of Longitude the Ship has made Weſterly.

CASE 3.

Courſe and Difference of Latitude given, to find the Diſtance ſailed, and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 53°, 34′ North, ſails S E *b* S, 'till by Obſervation ſhe is found to be in the Latitude of 51°, 12′, and conſequently has differed her Latitude 2°, 22′, or 142 Miles; required the Diſtance ſailed, and the Difference of Longitude.

Firſt, For the Departure it will be, by *Caſe* 2. *of Plane Sailing*,

As Radius		10.00000
is to the Diff. of Latitude	142	2.15229
ſo is the Tang. of Courſe	33°, 45′	9.82489
to the Departure	94.88	1.97718

And for the Diſtance it will be, by the ſame *Caſe*,

As

As Radius - - - - - - - - - -		10.00000
is to the Diff. of Latitude	142 - - -	2.15229
ſo is the Secant of the Courſe	33°, 45' -	10.08015
to the Diſtance - - - -	170.8 -	2.23244

Then, ſince the Latitude ſailed from was 53°, 34' North, and the Latitude come to 51°, 12' North, therefore the middle *Parallel* will be 50°, 23', and conſequently for the Difference of Longitude, it will be (by *Caſe* 2. *of Parallel Sailing*)

As the Co-ſine of the mid. *Parallel*	52°, 23'	9.78560
is to the Departure - - - -	94.88	1.97718
ſo is Radius - - - - - - - - -		10.00000
to min. of Diff. of Longitude -	155.5	2.19158

equal to 2°, 35', the Difference of Longitude Eaſterly.

CASE 4.

Difference of Latitude and Diſtance ſailed given, to find the Courſe and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 43°, 26' North, ſails between the South and Eaſt 246 Miles, and then is found by Obſervation to be in the Latitude of 41°, 06' North; required the direct Courſe and Difference of Longitude.

Firſt, For the Courſe it will be, by *Caſe* 3. *of Plane Sailing*,

As the Diſtance - - -	246 -	2.39094
is to Radius - - - - -		10.00000

ſo is the Diff. of Latitude - 140 - - 2.14613
to the Co-ſine of the Courſe 55°, 19′ - 9.75519.
which, becauſe the Ship ſails between South and Eaſt, will be South 55°, 19′ Eaſt, or S E *b* E nearly.

Then for Departure it will be, by the ſame *Caſe*,
As Radius - - - - - - - - - - - 10.00000
is to the Diſtance - - 246 - - - 2.39094
ſo is the Sine of the Courſe 55°, 19′ - - 9.91504
to the Departure - - - 202.3 - - 2.30598

Laſtly, For the Difference of Longitude it will be, by *Caſe* 2. *of Parallel Sailing*,
As the Co-ſine of the mid. *Par.* 42°, 16′ 9.86924
is to the Departure - - - 202.3 - - 2.30598
ſo is Radius - - - - - - - - - - 10.00000
to min. of Diff. of Longitude 273.3 - 2.43674
equal to 4°, 33′ the Difference of Longitude Eaſterly.

CASE 5.

Courſe and Departure given, to find Difference of Latitude, Difference of Longitude, and Diſtance ſailed.

Example.

Suppoſe a Ship in the Latitude of 48°, 23′ North, ſails S W *b* S, 'till ſhe has made of Weſting 123 Miles; required the Latitude come to, the Difference of Longitude, and the Diſtance ſailed.

Firſt, For the Diſtance it will be, by *Caſe* 6. *of Plane Sailing*,

As the Sine of the Courſe - 33°, 45' - 9.74474
is to the Departure - - - 123 - - 2.08991
ſo is Radius - - - - - - - - - 10.00000
to the Diſtance - - - - 221.4 - 2.34517

And for the Difference of Latitude it will be, by the ſame *Caſe*,

As the Tang. of Courſe - 33°, 45' - 9.82489
is to the Departure - - - 123 - - 2.08991
ſo is Radius - - - - - - - - - - 10.00000
to the Diff. of Latitude - - 184 - 2.26502

equal to 3°, 04'; and ſince the Ship is ſailing towards the Equator, the Latitude come to will be 45°, 19' North, and conſequently the middle *Parallel* will be 46°, 51' N.

Then to find the Difference of Longitude it will be, by *Caſe* 2. *of Parallel Sailing*,
As the Co-ſine of mid. *Par.* 46, 51' - 9.83500
is to the Departure - 123 - 2.08991
ſo is Radius - - - - - 10.00000
to min. of Diff. of Longit. - 180 - 2.25491
which is equal to 3°, 00', the Difference of Longitude Weſterley.

CASE 6.

Difference of Latitude and Departure given, to find Courſe, Diſtance, and Difference of Longitude.

Example.

Suppoſe a Ship in the Latitude of 46°, 37' North, ſails between South and Eaſt, 'till ſhe has made of Eaſting 146 Miles, and is then found by Obſervation to be in the Latitude of 43°, 24′ North; required the Courſe, Diſtance, and Difference of Longitude.

Firſt, By *Caſe* 4. *of Plane Sailing*, it will be for the Courſe,

As the Diff. of Latitude - 193 - - 2.28556
is to Departure - - - - 146 - - 2.16435
ſo is Radius - - - - - - - - - 10.00000
to the Tang. of the Courſe 37°, 6′ - 9.87879
which, becauſe the Ship is ſailing between South and Eaſt, will be South 37°, 6′ Eaſt, or S E *b* S ¼ Eaſt nearly.

For the Diſtance it will be, by the ſame *Caſe*,

As Radius - - - - - - - - - 10.00000
is to the Diff. of Latitude - 193 - - 2.28556
ſo is the Secant of the Courſe 37°, 6′ - 10.09822
to the Diſtance - - - - 241.9 - 2.38378

Then for the Difference of Longitude it will be, by *Caſe* 2. *of Parallel Sailing*,

As the Co-ſine of the mid *Par.* 45°, 00′ 9.84949
is to the Departure - - - - 146 - 2.16435
ſo is Radius - - - - - - - - 10.00000
to min. of Diff. of Longitude 206.4 - 2.31486
equal to 3°, 26′, the Difference of Longitude Eaſterly.

CASE 7.

Diſtance and Departure given, to find Difference of Latitude, Courſe, and Difference of Longitude.

Example,

Example.

Suppoſe a Ship in the Latitude of 33°, 40′ North, ſails between South and Eaſt 165 Miles, and has then made of Eaſting 112.5 Miles; required the Difference of Latitude, Courſe, and Difference of Longitude.

Firſt, By the Courſe it will be, by *Caſe* 5. *of Plane Sailing*,

As the Diſtance	165	2.21748
is to Radius		10.00000
ſo is the Departure	112.5	1.05115
to the Sine of the Courſe	42°, 59′	9.83367

which, becauſe the Ship ſails between South and Eaſt, will be South 42°, 59′ Eaſt, or S E *b* S $\frac{3}{4}$ Eaſt nearly.

And for the Difference of Latitude it will be, by the ſame *Caſe*,

As Radius		10.00000
is to the Diſtance	165	2.21748
ſo is the Co-ſine of the Courſe	42°, 59′	9.86436
to the Diff. of Latitude	120.7	2.08184

equal to 2°, 00′; conſequently the Latitude come to will be 31°, 40′ North, and the Latitude of the middle *Parallel* will be 32°, 40′. Hence to find the Difference of Longitude it will be, by *Caſe* 2. *of Parallel Sailing*,

As the Co-ſine of the mid. *Par.*	32°, 40′	9.92522
is to the Departure	112.5	2.05115

ſo is Radius - - - - - - - - - 10.00000
to min. of Diff. of Long. - 133.6 - 2.12593
equal to 2°, 13′ nearly, the Difference of Longitude Eaſterly.

CASE 8.

Difference of Longitude and Departure given, to find Difference of Latitude, Courſe, and Diſtance ſailed.

Example.

Suppoſe a Ship in the Latitude of 50°, 46′ North, ſails between South and Weſt, 'till her Difference of Longitude is 3°, 12′, and is then found to have departed from her former Meridian 126 Miles; required the Difference of Latitude, Courſe, and Diſtance ſailed.

Firſt, For the Latitude ſhe has come to it will be, by *Caſe* 3. *of Parallel Sailing*,

As Min. of Diff. of Long. - 192 - - 2.28330
is to Departure - - - - 126 - - 2.10037
ſo is Radius - - - - - - - - - 10.00000
to the Co-ſine of the mid. *Par.* 48°, 59′ - 9.81707

Now ſince the middle Latitude is equal to Half the Sum of the two Latitudes (by *Art.* 1. of this *Sect.*) and ſo the Sum of the two Latitudes equal to double the middle Latitude; it follows, that if from double the middle Latitude we ſubtract any one of the Latitudes, the Remainder will be the other. Hence from twice 48°, 59′, *viz.* 97°, 58′, taking 50°, 46′ the Latitude ſailed from, there remains 47°, 12′ the Latitude come to. Conſequently the Difference of Latitude is 3°, 34′, or 214 Minutes.

Then for the Courſe it will be, by *Caſe* 4. *of Plane Sailing*,

As Diff. of Lat. - - -	214 - - -	2.33041
is to Radius - - - - - - - - - -		10.00000
ſo is the Departure - -	126 - - -	2.10037
to the Tang. of the Courſe	30°, 29′ -	9.76996

which, becauſe it is between South and Weſt, will be South 30°, 29′ Weſt, or S S W ¾ Weſt nearly.

And for the Diſtance it will be, by the ſame *Caſe*,

As Radius - - - - - - - - - -		10.00000
is to the Diff. of Lat. - -	214 - -	2.33041
ſo is the Secant of the Courſe	30°, 29′ -	10.06461
to the Diſtance - - - -	248.4 - -	2.39502

2. From what has been ſaid, it will be eaſy to ſolve a Traverſe, by the Rules of *Middle Latitude Sailing*.

Example.

Suppoſe a Ship in the Latitude of 43°, 25′ North, ſails upon the following Courſes, *viz.* S W *b* S 63 Miles, S S W ½ Weſt 45 Miles, S *b* E 54 Miles, and S W *b* W 74 Miles; required the Latitude the Ship has come to, and how far ſhe has differed her Longitude.

Firſt, By *Caſe* 2. of this *Sect.* find the Difference of Latitude, and Difference of Longitude belonging to each Courſe and Diſtance, and they will ſtand as in the following Table.

Courſes

Courſes.	*Diſtances.*	*Diff. of Lat.*		*Diff. of Longit.*	
		N.	*S.*	*E.*	*W.*
S W *b* S - -	63	—	52.4	—	47.85
S S W ½ Weſt -	45	—	39.7	—	28.62
S *b* E - - -	54	—	53.0	13.75	—
S W *b* W - -	74	—	41.1	—	81.08
		Diff. of Lat.	186.2		157.55 13.75
				Diff. of Long.	143.80

Hence it is plain the Ship has differed her Latitude 186.2 Minutes, or 3°, 6′, and ſo has come to the Latitude of 40°, 19′ North, and has made of Difference of Longitude 143.80 Minutes, or 2°, 23′, 48″ Weſterley.

3. This Method of ſailing, though not ſtrictly true, yet comes very near the Truth, as will be evident, by comparing an Example wrought by this Method, with the ſame wrought by the Method delivered in the next *Section*, which is ſtrictly true. This Method however ſerves without any conſiderable Error, in Runnings of 450 Miles between the *Equator* and *Parallel* of 30 Degrees; of 300 Miles between that and the Parallel of 60 Degrees; and of 150 Miles, as far as there is any Occaſion, and conſequently muſt be ſufficiently exact for 24 Hours Run.

SECT. X.

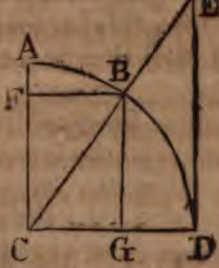
Of Mercator's Sailing.

1. THO' the *Meridians* do all meet at the *Pole*, and the *Parallels* to the *Equator* do continually decreaſe, and that in Proportion to the Coſines of their Latitudes; yet in old Sea *Charts* the *Meridians*

Meridians were drawn parallel to one another, and conſequently the *Parallels* of Latitude made equal to the *Equator*, and ſo a Degree of Longitude on any *Parallel*, as large as a Degree on the *Equator*; alſo in theſe Charts the Degrees of Latitude were ſtill repreſented (as they are in themſelves) equal to each other and to thoſe of the *Equator*. By theſe Means the Degrees of Longitude being increaſed beyond their juſt Proportion, and the more ſo the nearer they approach the Pole; the Degrees of Latitude at the ſame Time remaining the ſame, 'tis evident Places muſt be very erroneouſly marked down upon theſe Charts, with reſpect to their Latitude and Longitude, and conſequently their bearing from one another very falſe.

2. To remedy this Inconvenience, ſo as ſtill to keep the *Meridians* parallel, 'tis plain we muſt protract, or lengthen, the Degrees of Latitude in the ſame Proportion as thoſe of Longitude are, that ſo the Proportion in *Eaſting* and *Weſting*, may be the ſame with that of *Southing* and *Northing*, and conſequently the Bearings of Places from one another, be the ſame upon the Chart as upon the Globe itſelf.

3. In the annexed Scheme let ABD be a Quadrant of a *Meridian*, A the *Pole*, D a *Point* on the *Equator*, A C half the *Axis*, B any *Point* upon the *Meridian*, from which draw B F perpendicular to A C, and B G perpendicular to C D; then B G will be the Sine, and B F or C G the Coſine of B D the Latitude of the *Point* B: Draw D E the Tangent and C E Secant of the Arch B D. It has been demonſtrated in *Sect.* VIII. that any Arch of a Parallel, is to the like Arch of the *Equator*, as the Co-ſine of the Latitude of that Parallel is to Radius; thus any Arch as a Minute on the Parallel deſcribed by the



Point B, will be to a Minute on the *Equator*, as BF or CG is to CD; but ſince the Triangles CGB, CDE are ſimilar, therefore (by *Art.* 73. *Sect.* I.) CG will be to CD as CB is to CE, *i. e.* the Co-ſine of any *Parallel* is to *Radius* as *Radius* is to the Secant of the Latitude of that *Parallel*; but it has been juſt now ſhewn, that the Co-ſine of any *Parallel* is to *Radius*, as the Length of any Arch as a Minute on that *Parallel*, is to the Length of the like Arch on the *Equator*: Therefore the Length of any Arch as a Minute on any *Parallel*, is to the Length of the like Arch on the *Equator*, as *Radius* is to the Secant of the Latitude of that *Parallel*; and ſo the Length of any Arch, as a Minute on the *Equator*, is longer than the like Arch of any *Parallel* in the ſame Proportion, as the Secant of the Latitude of that *Parallel* is to *Radius*. But ſince in this Projection the *Meridians* are parallel, and conſequently each *Parallel* of Latitude equal to the *Equator*, 'tis plain the Length of any Arch, as a Minute on any *Parallel*, is increaſed beyond it's juſt Proportion, at ſuch Rate as the Secant of the Latitude of that *Parallel* is greater than *Radius*; and therefore to keep up the Proportion of *Northing* and *Southing*, to that of *Eaſting* and *Weſting*, upon this Chart, as it is upon the Globe itſelf, the Length of a Minute upon the *Meridian* at any *Parallel*, muſt alſo be increaſed beyond it's juſt Proportion at the ſame Rate, *i. e.* as the Secant of the Latitude of that *Parallel* is greater than *Radius*. Thus to find the Length of a Minute upon the *Meridian* at the Latitude of 75 Degrees, ſince a Minute of a *Meridian* is every where equal on the Globe, and alſo equal to a Minute upon the *Equator*, let it be repreſented by Unity; then making it As *Radius* is to the Secant of 75 Degrees, So is Unity to a fourth Number, which is 3.864 nearly, and conſequently by whatever Line you repreſent one Minute on the *Equator* of this Chart, the Length of one Minute on the enlarged *Meridian* at the Latitude of 75 Degrees, or the Diſtance between the *Parallel* of 75°, 00′, and the *Parallel* of 75°, 01′, will be equal to 3 of theſe Lines, and $\frac{864}{1000}$ of one of them. By making the ſame Proportion it will be found, that the Length of a Minute on the Meridian of this Chart at the *Parallel* of 60°, or the Diſtance between the *Parallel* of 60°, 00′, and that of 60°, 01′ is equal to 2 of theſe Lines. After the ſame Manner, the Length of a Minute on the enlarged *Meridian*, may be found at any Latitude; and conſequently beginning at the *Equator*, and computing the Length of every intermediate Minute, between that and any *Parallel*, the Sum of all theſe ſhall be the Length of a Meridian intercepted between the *Equator* and that *Parallel*; and the Diſtance of each Degree and Minute of Latitude, from the *Equator* upon the *Meridian* of this Chart, computed in Minutes of the *Equator*, forms what is commonly called a Table of Meridional Parts.

If the Arch B D repreſent the Latitude of any *Point* B, then (C D being *Radius*) C E will be the Secant of that Latitude; but it has been ſhewn above, that *Radius* is to the Secant of any Latitude, as the Length of a Minute upon the *Equator*, is to the Length of a Minute on the *Meridian* of this Chart at that Latitude; therefore C D is to C E, as the Length of a Minute on the *Equator* is to the Length of a Minute upon the *Meridian*, at the Latitude of the *Point* B. Conſequently if the *Radius* C D be taken equal to the Length of a Minute upon the *Equator* C E, or the Secant of the Latitude, will be equal to the Length of a Minute upon the *Meridian* at that Latitude. Therefore, in general, if the Length of a Minute upon the *Equator* be made *Radius*, the Length of a Minute upon the enlarged *Meridian* will be every where equal to the Secant of the Arch contained between it and the *Equator*.

Cor. 1. Hence it follows, ſince the Length of every intermediate Minute between the *Equator* and any *Parallel*, is equal to the Secant of the Latitude (the *Radius* being equal to a Minute upon the *Equator*) the Sum of all theſe Lengths, or the Diſtance of that *Parallel* on the enlarged *Meridian* from the *Equator*, will be equal to the Sum of all the Secants, to every Minute contained between it and the *Equator*.

2. Conſequently the Diſtance between any two *Parallels* on the ſame Side of the *Equator*, is equal to the Difference of the Sums of all the Secants contained between the *Equator* and each *Parallel*; and the Diſtance between any two *Parallels* on contrary Sides of the *Equator*, is equal to the Sum of the Sums of all the Secants contained between the *Equator* and each *Parallel*.

3. There is annexed to the End of this *Section*, a Table of Meridional Parts, for every Degree and Minute of Latitude, in which you may obſerve that the Top Column contains the Degrees, and the left Hand-ſide Column the Minutes, the other Columns contain the Meridional Parts anſwering to each Degree and Minute, or the Diſtance of each Degree and Minute of Latitude in this Chart from the *Equator*, counted in Minutes of the *Equator*. Thus for the Latitude of 63°, 20′, I look in the Top Column for 63°, and in the left Hand-ſide Column for 20′, and in the Column under 63° and on the ſame Line with 20′, I find the Number 4949.3, which is the Meridional Parts for the *Parallel* of 63°, 20′, or it ſhews that the Part of the enlarged Meridian, which is intercepted between the *Equator* and the *Parallel* of 63°, 20′, contains 4949.3 Minutes of the *Equator*, whereas upon the Globe it contains only 3800. In this Table you may likewiſe obſerve, that the Meridional Parts are computed only to one Place of Decimals, which is ſufficiently exact for all common Purpoſes.

4. By theſe Tables may be conſtructed the nautical Chart, commonly called *Mercator's* Chart. Thus, for Example, let it be required to make a Chart that ſhall commence at the *Equator*, and reach to the *Parallel* of 60 Degrees, and ſhall contain 80 Degrees of Longitude.

Draw the Line E Q repreſenting the *Equator*; (ſee *Plate* 1.) then take from any convenient Line of equal Parts, 4800 (the Number of Minutes contained in 80 Degrees) which ſet off from E to Q, and this will determine the Breadth of the Chart.

Divide the Line E Q into eight equal Parts, in the Points 10, 20, 30, *&c.* each containing 10 Degrees, and each of theſe divided into 10 equal Parts will give the ſingle Degrees upon the *Equator*; then thro' the Points E, 10, 20, *&c.* drawing Lines perpendicular to E Q; theſe ſhall be Meridians.

From the Scale of equal Parts take 4527.4 (the Meridional Parts anſwering to 60 Degrees) and ſet that off from E to A and from Q to B, and join A B; then this Line will repreſent the *Parallel* of 60, and will determine the Length of the Chart.

Again, from the Scale of equal Parts take 603.1, (the Meridional Parts anſwering to 10 Degrees) and ſet that off from E to 10 on the Line E A, and thro' the Point 10 draw 10, 10, parallel to E Q, and this will be the *Parallel* of 10 Degrees. The ſame Way ſetting off from E on the Line E A, the Meridional Parts anſwering to each Degree, *&c.* of Latitude, and through the ſeveral Points drawing Lines parallel to E Q, we ſhall have the ſeveral *Parallels* of Latitude.

If the Chart does not commence from the *Equator*, but is only to ſerve for a certain Diſtance on the *Meridian*, between two given *Parallels* on the ſame Side of the *Equator*; then the *Meridians* are to be drawn as in the laſt Example, and for the *Parallels* of Latitude you are to proceed thus; *viz.* from the Meridional Parts anſwering to each Point of Latitude in your Chart, ſubtract the Meridional Parts anſwering to the leaſt Latitude, and ſet off the Differences ſeverally, from the *Parallel* of leaſt Latitude, upon the two extream *Meridians*, and the Lines joining theſe Points of the *Meridians* ſhall repreſent the ſeveral *Parallels* upon your Chart.

Thus let it be required to draw a Chart that ſhall ſerve from the Latitude of 20 Degrees North, to 60 Degrees North, and that ſhall contain 80 Degrees of Longitude.

Having drawn the Line DC to repreſent the *Parallel* of 20 Degrees (ſee *Plate* 1.) and the *Meridians* to it, as in the foregoing Example; ſet off 663.3 (the Difference between the Meridional Parts anſwering to 30 Degrees, and thoſe of 20 Degrees) from D to 30, and from C to 30; then join the Points 30 and 30 with a right Line, and that ſhall be the *Parallel* of 30. Alſo ſet off 1397.6 (the Difference between the Meridional Parts anſwering to 40 Degrees, and thoſe of 20 Degrees) from D to 40, and from C to 40, and joining the Points 40 and 40 with a right Line, that ſhall be the *Parallel* of 40. And proceeding after the ſame Way, we may draw as many of the intermediate *Parallels* as we have Occaſion for.

But if the two *Parallels* of Latitude that bound the Chart, are on the contrary Sides of the *Equator*; then draw a Line repreſenting the *Equator* and *Meridians* to it, as in the firſt Example; and from the *Equator* ſet off on each Side of it the ſeveral *Parallels* contained between it and the given *Parallels* as above, and your Chart is finiſhed.

If *Mercator*'s Chart, conſtructed as above, hath it's *Equator* extended on each Side of the Point E 180 Degrees, and if the ſeveral Places on the Surface of the Earth, be there laid down according to their Latitudes and Longitudes, we ſhall have what is commonly called *Mercator*'s Map of the Earth. This

Map is not to be conſidered as a ſimilar and juſt Repreſentation of the Earth's Surface, for in it the Figures of Countries are diſtorted, eſpecially near the *Poles*; but ſince the Degrees of Latitude are every where increaſed in the ſame Proportion as thoſe of Longitude are, the Bearings between the Places will be the ſame in this Chart as on the Globe, and the Proportions between the Latitudes, Longitudes, and nautical Diſtances, will alſo be the ſame on this Chart, as on the Globe itſelf; by which Means the ſeveral Caſes of Navigation are ſolved after a moſt eaſy Manner, and adapted to the meaneſt Capacities.

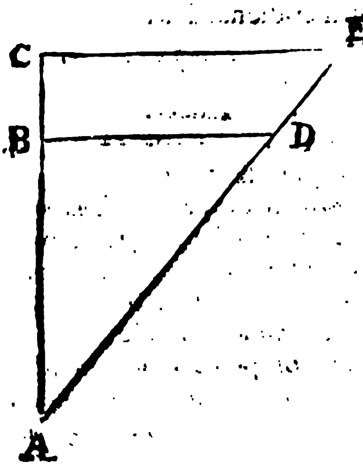
N.B. Here you muſt take Notice, that in all Charts, the upper Part is the *North* Side, and the lower Part or Bottom is the *South* Side; alſo that Part of it towards the right Hand is the *Eaſt*, and that towards the left Hand the *Weſt* Side of the Chart.

5. Since according to this Projection, the *Meridians* are parallel right Lines; 'tis plain, that the Rumbs which form always equal Angles with the *Meridians*, will be ſtreight Lines; which Property renders this Projection of the Earth's Surface much more eaſy and proper for nautical Uſes than any other.

6. This Method of projecting the Earth's Surface upon a Plane, was firſt invented by Mr. *Edw. Wright*, but firſt publiſhed by *Mercator*; and hence the ſailing by this Chart was called *Mercator*'s Sailing.

7. In the annexed Scheme, let A and E repreſent two Places upon *Mercator*'s *Chart*, A C the *Meridian* of A, and C E the *Parallel* of Latitude paſſing thro' E; draw A E, and ſet off upon A C the Length A B equal to the Number of Minutes contained in the Difference of Latitude between the two Places, and taken from the ſame Scale of equal Parts the Chart was made by; or from the *Equator*, or any graduated *Parallel* of the Chart, and thro' B, draw B D parallel to C E meeting A E in D. Then A C will be the *enlarged Difference of Latitude*, A B the *proper Difference*

of Latitude; C E the *Difference of Longitude*; B D the *Departure*, A E the *enlarged Diſtance*, and A D the



proper Diſtance, between the two Places A and E; alſo the Angle B A D will be the Courſe, and A E the Rumb Line between them.

8. Now ſince in the Triangle A C E, B D is parallel to one of it's Sides C E; 'tis plain the Triangles A C E, A B D will be ſimilar, and conſequently the Sides proportional (by *Art.* 73. *Sect.* 1.) Hence ariſe the Solutions of the ſeveral *Caſes* in this ſailing, which are as follow.

CASE I.

The Latitudes of two Places given, to find the meridional or enlarged Difference of Latitude between them.

Of this *Caſe* there are three Varieties, *viz.* either one of the Places lies on the *Equator*, or both on the ſame Side of it; or laſtly on different Sides.

1. If one of the propoſed Places lies on the *Equator*, then the meridional Difference of Latitude is the ſame with the Latitude of the other Place, taken from the Table of meridional Parts.

Example.

Required the meridional Difference of Latitude between *St. Thomas*, lying on the *Equator*, and *St. Antonio*, in the Latitude of 17°, 20′ North. I look in the following Table for the meridional Parts anſwering to 17°, 20′, and find it to be 1056.2, the enlarged Difference of Latitude required.

2. If the two propoſed Places be on the ſame Side of the *Equator*, then the meridional Difference of Latitude is found by ſubtracting the meridional Parts anſwering to the leaſt Latitude, from thoſe anſwering to the greateſt, and the Difference is that required.

Example.

Required the meridional Difference of Latitude between the *Lizard*, in the Latitude of 50°, 00′ North, and *Antigua*, in the Latitude of 17°, 30′ North.

From the meridional Parts of - 50°, 00′ - 3474.5
ſubtract the meridional Parts of 17 , 30 - 1066.7

there remains - - - - - - - - - 2407.8
the meridional Difference of Latitude required.

3. If the Places lie on different Sides of the *Equator*, then the meridional Difference of Latitude is found by adding together the meridional Parts anſwering to each Latitude, and the Sum is that required.

Example.

Required the meridional Difference of Latitude between *Antigua*, in the Latitude of 17°, 30′ North, and *Lima*, in *Peru*, in the Latitude of 12°, 30′ South.

To the merid. Parts anſwering to 17°, 30′ - 1066.7
add theſe anſwering to - - - 12°, 30′ - 756.1

the Sum is - - - - - - - - - - - 1822.8
the meridional Difference of Latitude required.

CASE 2.

The Latitude and Longitude of two Places given, to find the direct Courſe and Diſtance between them.

Example.

Required to find the direct Courſe and Diſtance between the *Lizard*, in the Latitude of 50°, 00′ North, and *Port-Royal* in *Jamaica*, in the Latitude of 17°, 40′ North, differing in Longitude 70°, 46′ Weſt, *Port-Royal* lying ſo far to the Weſtward of the *Lizard*.

Preparation.

From the Latitude of the *Lizard* - 50°, 00′ N.
ſubtract the Latitude of *Port-Royal* - 17°, 40′ N.

and there remains - - - - - - - 32°, 20′ N.
equal to 1940 Minutes, the proper Difference of Latitude.

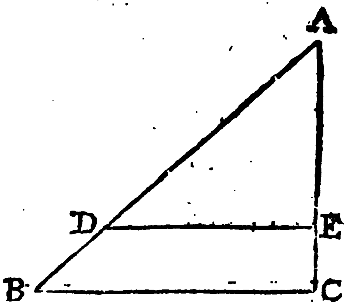
Then

Then from the meridional Parts of	50°, 00′	3474.5
ſubtract thoſe of - - - - - -	17°, 40′	1077.2
and there remains - - - - - - - - -		2397.3

the meridional or enlarged Difference of Longitude.

Geometrically.

Draw the Line A C, repreſenting the *Meridian* of the *Lizard* at A, and ſet off from A upon that Line, A E equal to 1940 (from any Scale of equal Parts) the proper Difference of Latitude, alſo A C equal to 2397.3 (from the ſame Scale) the meridional or enlarged Difference of Latitude. Upon the Point C raiſe C B perpendicular to A C, and make C B equal to 4246, the Minutes of Difference of Longitude.



Join A B, and thro' E draw E D parallel to B C; ſo the *Caſe* is conſtructed, and A D applied to the ſame Scale of equal Parts the other Legs were taken from, will give the direct Diſtance, and the Angle D A E, meaſured by the Line of Chords, will give the Courſe.

By Calculation.

For the Angle of the Courſe E A D it will be, by *Caſe* 4. *of Rectangular Trigonometry*,

AC : CB :: R : T, BAC, *i. e.*

As the meridional Diff. of Lat.	2397.3	3.37970
is to the Difference of Long.	4246.0	3.62798
ſo is Radius		10.00000
to the Tang. of the direct Courſe	60°, 33′	10.24828

which, becauſe *Port-Royal* is Southward of the *Lizard*, and the Difference of Longitude Weſterly, will be South 60°, 33′ Weſt, or S W *b* W ½ Weſt nearly.

Then for the Diſtance A D it will be, by *Caſe* 2. *of Rectangular Trigonometry*,

R : AE :: Sec. A : AD, *i. e.*

As the Radius		10.00000
is to the proper Diff. of Lat.	1940	3.28780
ſo is the Secant of the Courſe	60°, 33′	10.30833
to the Diſtance	3945.6	3.59613

conſequently the direct Courſe between the *Lizard* and *Port-Royal* in *Jamaica*, is South 60°, 33′, and the Diſtance 3945.6 Miles.

CASE 3.

Courſe and Diſtance ſailed given, to find Difference of Latitude and Difference of Longitude.

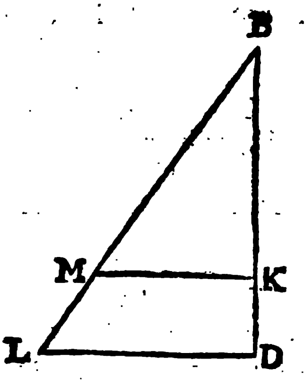
Example.

Example.

Suppoſe a Ship from the *Lizard*, in the Latitude of 50°, 00′ North, ſails South 35°, 40′ Weſt 156 Miles; required the Latitude come to, and how much ſhe has altered her Longitude.

Geometrically.

1. Draw the Line BK repreſenting the *Meridian* of the *Lizard* at B; from B draw the Line BM, making with BK an Angle equal to 35°, 40′, and



upon this Line ſet off BM equal to 156, the given Diſtance, and from M let fall the Perpendicular MK upon BK.

Then for BK, the proper Difference of Latitude, it will be, by *Caſe* 3. *of Rectangular Trigonometry*,

R : MB : : S, BMK : BK.

i. e. As Radius - - - - - - - - - 10.00000
is to the Diſtance - - 156 - - - 2.19312

ſo is the Co-ſine of the Courſe 35°, 40′ -	9.90978
to the proper Difference of Lat. 127 -	2.10290

equal to 2°, 07′; and ſince the Ship is ſailing from a North Latitude towards the South, therefore the Latitude come to will be 47°, 53′ North. Hence the meridional Difference of Latitude will be 193.4.

2. Produce BK to D, 'till BD be equal to 193.4; thro' D draw DL parallel to MK, meeting DM produced in L; then DL will be the Difference of Longitude: To find which by Calculation it will be, by *Caſe* 1. *of Rectangular Trigonometry*,

R : BD :: T, LBD : DL,

i. e. As Radius - - - - - - - - -	10.00000
is to the meridional Diff. of Lat. 193.4 -	2.28646
ſo is the Tangent of the Courſe 35°, 40′	9.85594
to the Minutes of Diff. of Long. 138.8 -	2.14240

equal to 2°, 18′, 48″, the Difference of Longitude the Ship has made Weſterly.

CASE 4.

Given Courſe and both Latitudes, viz. *the Latitude ſailed from, and the Latitude come to, to find the Diſtance ſailed and the Difference of Longitude.*

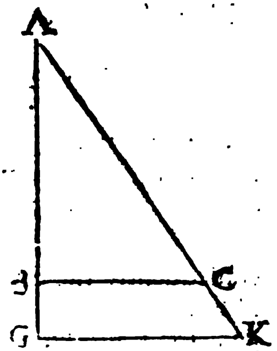
Example.

Suppoſe a Ship in the Latitude of 54°, 20′ North, ſails South 33°, 45′ Eaſt, 'till by Obſervation ſhe is found to be in the Latitude of 51°, 45′ North; required the Diſtance ſailed, and the Difference of Longitude.

Geometrically.

Geometrically.

Draw AB to repreſent the Meridian of the Ship in the firſt Latitude, and ſet off from A to B 166, the Minutes of the proper Difference of Latitude, alſo AG equal to 257.9, the Minutes of the enlarged Difference of Latitude. Thro' B and G draw the Lines BC and GK perpendicular to AG; alſo draw AK, making with AG an Angle of 33°, 45′, which will meet the two former Lines in the Points C and K; ſo the Caſe is conſtructed, and AC and GK may be found from the Line of equal Parts: To find which



By Calculation.

Firſt, For the Difference of Longitude it will be, by *Caſe* 1. *of Rectangular Trigonometry*,

R : AG :: T, GAK : GK,

i. e. As Radius - - - - - - - - - 10.00000
is to the enlarged Diff. of Lat. - 257.9 - 2.41145
ſo is the Tang. of the Courſe 33°, 45′ - 9.82489
to the Min. of Diff. of Long. - 172.3 - 2.23634
equal to 2°, 52′, 18″, the Difference of Longitude the Ship has made Eaſterly.

This might alſo have been found, by firſt finding the Departure BC (by *Caſe* 2. *of Plane Sailing*) and then (by *Art.* 74. *Sect.* I.) it would be

AB : BC :: AG : GK. The Difference of Longitude required.

Then for the direct Diſtance AC, it will be, by *Caſe* 2. *of Rectangular Trigonometry*,

R : AB :: Sec. A : AC,

i. e. As Radius - - - - - - - - - 10.00000
is to the proper Diff. of Lat. - 155 - 2.19033
ſo is the Secant of the Courſe - 33°, 45′ 10.08015
to the direct Diſtance - - - 186.4 - 2.27048
conſequently the Ship has ſailed South 33°, 45′ Eaſt, 186.4 Miles, and has differed her Longitude 2°, 52′, 18″ Eaſterly.

CASE 5.

Both Latitudes, and Diſtance ſailed, given, to find the direct Courſe, and Difference of Longitude.

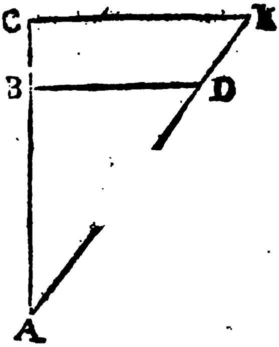
Example.

Suppoſe a Ship from the Latitude of 45°, 26′ North, ſails between North and Eaſt 195 Miles, and then by Obſervation ſhe's found to be in the Latitude of 48°, 6′ North; required the direct Courſe and Difference of Longitude.

Geometrically.

Geometrically.

Draw A B equal to 160 the proper Difference of Latitude, and from the Point B raiſe the Perpendicular B D; then take 195 in your Compaſſes; and ſetting one Foot of them in A, with the other croſs the Line B D in D. Produce A B 'till A C be equal to 233.6 the enlarged Difference of Latitude. Thro' C draw C K parallel to B D, meeting A D produced in K; ſo the Caſe is conſtructed, and the Angle A may be meaſured by the Line of Chords, and C K by the Line of equal Parts. To find which



By Calculation.

Firſt, For the Angle of the Courſe B A D it will be, by *Caſe* 5. *of Rectangular Trigonometry*,

A B : R : : A D : Sec. A *i. e.*

As the proper Diff. of Lat.	160	2.20412
is to Radius		10.00000
ſo is the Diſtance	195	2.29003
to the Secant of the Courſe	34°, 52′	10.08591

which, becauſe the Ship is ſailing between North and Eaſt, will be North 34°, 52′ Eaſt, or N E *b* N 1°, 7′ Eaſterly.

Then for the Difference of Longitude it will be, by *Caſe* 1. *of Rectangular Trigonometry*, R : A C : : T, A : C K.

i. e. As Radius - - - - - - - - - 10.00000
is to the merid. Diff. of Lat. - 233.6 - 2.36847
ſo is the Tang. of the Courſe 34°, 52′ - 9.84307
to the Min. Diff. of Longitude 162.8 - - 2.21164
equal to 2°, 42′, 48″, the Difference of Longitude Eaſterly.

CASE 6.

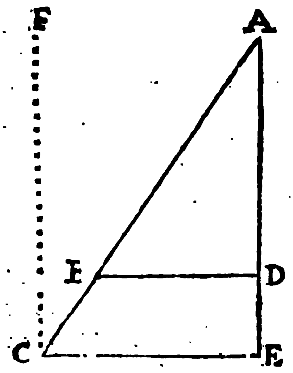
One Latitude, Courſe, and Difference of Longitude, given, to find the other Latitude, and Diſtance ſailed.

Example.

Suppoſe a Ship from the Latitude of 48°, 50′ North, ſails South 34°, 40′ Weſt, 'till her Difference of Longitude is 2°, 44′; required the Latitude come to, and the Diſtance ſailed.

Geometrically.

1. Draw A E to repreſent the Meridian of the Ship in the firſt Latitude, and make the Angle E A C equal to 34°, 40′, the Angle of the Courſe; then draw F C parallel to A E, at the Diſtance of 164, the Minutes of Difference of Longitude, which will meet A C in the Point C. From C let fall upon A E the Perpendicular C E; then A E will be the enlarged Difference of Latitude. To find which, *by Calculation* it will be, by *Caſe* 1. *Rectangular Trigonometry*,



T, A : R : : CE : AE.

i. e. As the Tang. of the Courſe 34°, 40′ 9.83984
is to the Radius - - - - - - - - - 10.00000
ſo is the Min. of Diff. Longitude 164 - 2.21484
to the enlarged Diff. of Latitude 237.2 - 2.37500
and becauſe the Ship is ſailing from a North Latitude Southerly. Therefore,
From the Merid. Parts of the Latitude ſailed from } - 48°, 50′ - 3366.9
take the merid. Difference of Latitude - 237.2

and there remains - - - - - - - - - 3129.7
the Meridional Parts of the Latitude come to, *viz.* 46°, 09′.

Hence for the proper Difference of Latitude,

From the Latitude ſailed from - - 48°, 50′ N.
take the Latitude come to - - - - 46, 09′ N.

and there remains - - - - - - - 2°, 41
equal to 161, the Minutes of Difference of Latitude.

2. Set off upon A E the Length A D equal to 161 the proper Difference of Latitude, and thro' D draw DB parallel to C E; then A B will be the direct Diſtance. To find which, *by Calculation* it will be, by *Caſe* 2. *of Rectangular Trigonometry*,

R : A D : : Sec. A : A B.

i. e. As Radius - - - - - - - - 10.00000
is to the proper Diff. of Latitude 161 - 2.20683
ſo is the Secant of the Courſe - 34°, 40′ 10.08488
to the direct Diſtance - - - 195.8 - 2.29171

CASE 7.

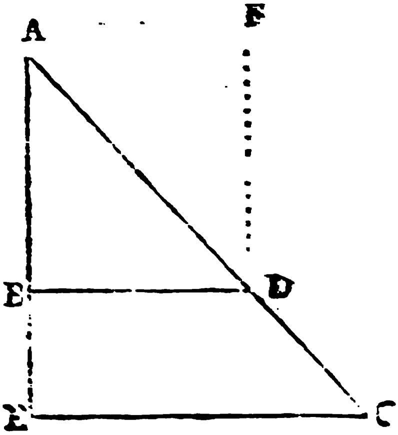
One Latitude, Courſe, and Departure, given, to find the other Latitude, Diſtance ſailed, and Difference of Longitude.

Example.

Suppoſe a Ship ſails from the Latitude of 54°, 36' North, Long. 42°, 33' Eaſt, 'till ſhe has made of Departure 116 Miles; required the Latitude ſhe is in, her direct Diſtance ſailed, and how much ſhe has altered her Longitude.

Geometrically.

1. Having drawn the Meridian A B, make the Angle B A D equal to 42°, 33'. Draw F D parallel to A B at the Diſtance of 116, which will meet A D in D. Let fall upon A B the Perpendicular D B. Then A B will be the proper Difference of Latitude, and



and A D the direct Diſtance, to find which, *by Calculation*; firſt, for the Diſtance A D it will be, by *Caſe* 2. *of Rectangular Trigonometry*,

S, A : BD : : R : AD.

i. e. As the Sine of the Courſe 42°, 33′ 9.83010
is to the Departure - - - - - 116 - 2.06446
ſo is Radius - - - - - - - - - - - 10.00000
to the direct Diſtance - - - 171.5 - 2.23436

Then for the proper Difference of Latitude it will be, by *Caſe* 1. *of Rectangular Trigonometry*,

T, A : BD : : R : AB.

i. e. As the Tang. of the Courſe 42°, 33′ 9.96281
is to the Departure - - - - - 116 - 2.06446
ſo is Radius - - - - - - - - - - - - 10.00000
to the proper Difference of Latitude 126.4 2.10165
equal to 2°, 6′, conſequently the Ship has come to the Latitude of 52°, 30′ North, and ſo the meridional Difference of Latitude will be 212.2.

2. Produce A B to E, 'till A E be equal to 212.2; and through E draw E C parallel to B D, meeting A D produced in C; then E C will be the Difference of Longitude, to find which, *by Calculation*, it will be, by *Caſe* 1. *of Rectangular Trigonometry*,

R : A E : : T, A : E C.

i. e. As Radius - - - - - - - - - - 10.00000
is to the merid. Diff. of Latitude 212.2 - 2.32675
ſo is the Tang. of the Courſe - 42°, 33′ 9.96281
to the Min. of Diff. of Longitude 194.8 - 2.28956
equal to 3°, 14′, 48″, the Difference of Longitude Eaſterly.

This might have been found otherwiſe, thus, becauſe the Triangles A C E, A D B are ſimilar, therefore (*by Art.* 73. *Sect.* 1.) it will be,

A B : B D : : A E : E C.

i. e. As the proper Diff. of Latitude	126.4	2.10165
is to the Departure - - - -	116 -	2.06446
ſo is the enlarged Diff. of Latitude	212.2	2.32675
to Min. Diff. of Longitude - -	194.8	2.28956

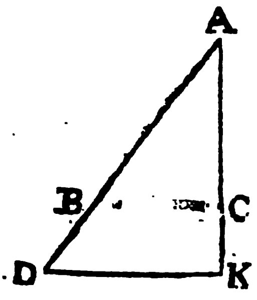
CASE 8.

Both Latitudes and Departure given, to find Courſe, Diſtance, and Difference of Longitude.

Example.

Suppoſe a Ship from the Latitude of 46°, 20′ N. ſails between the South and Weſt, 'till ſhe has made of Departure 126.4 Miles; and is then found by Obſervation to be in the Latitude of 43°, 35′ North; required the Courſe, Diſtance ſailed, and Difference of Longitude.

Geometrically.



Draw A K to repreſent the Meridian of the Ship in her firſt Latitude, ſet off upon it A C, equal to 165, the proper Difference of Latitude. Draw B C perpendicular at A C, equal to 126.4 the Departure, and join A B. Set off from A, A K equal to 233.3, the enlarged Difference of Latitude, and thro' K draw K D parallel to B C, meeting A B produced in D; ſo the *Caſe* is conſtructed, and

DK will be the Difference of Longitude, AB the Diſtance, and the Angle A the Courſe; to find which

By Calculation.

Firſt, For DK the Difference of Longitude, it will be, by *Art.* 73. *Sect.* 1.

AC:CB::AK:KD.

i. e. As the proper Diff. of Latitude	165	2.21748
is to the Departure - - - -	126.4	2.10175
ſo is the enlarged Diff. of Latitude	233.3	2.36791
to the Min. of Diff. of Longitude	178.7	2.25218

equal to 2°, 58′, 42″, the Difference of Longitude Weſterly.

Then for the Courſe it will be, by *Caſe* 4. *of Rectangular Trigonometry*,

AC:BC::R:T, A.

i. e. As the proper Diff. of Latitude	165	2.21748
is to Departure - - - - - - -	126.4	2.10175
ſo is Radius - - - - - - - - - - - -		10.00000
to the Tangent of the Courſe	37°, 27′ -	9.88427

which, becauſe the Ship ſails between South and Weſt, will be South 37°, 27′ Weſt, or S W *b* S 3°, 30′ Weſterly.

Laſtly, For the Diſtance AB, it will be, by *Caſe* 2. *of Rectangular Trigonometry*,

S, A:BC::R:AB.

i. e. As the Sine of the Courſe	37°, 27′	9.78395
is to the Departure	126.4	2.10175
ſo is Radius		10.00000
to the direct Diſtance	207.9	2.31780

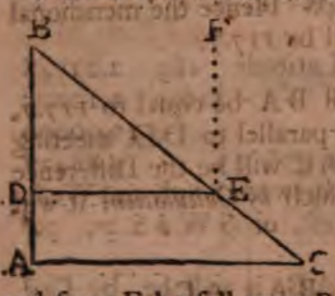
CASE 9.

One Latitude, Diſtance ſailed, and Departure given, to find the other Latitude, Difference of Longitude, and Courſe.

Example.

Suppoſe a Ship in the Latitude of 48°, 33′ North, ſails between South and Eaſt 138 Miles, and has then made of Departure 112.6; required the Latitude come to, the direct Courſe, and Difference of Longitude.

Geometrically.



1. Draw B D for the Meridian of the Ship at B, and parallel to it draw F E, at the Diſtance of 112.6 the Departure. Take 138, the Diſtance, in your Compaſſes, and fixing one Point of them in B, with the other croſs the Line F E in the Point E; then join B and E, and from E let fall upon B D the Perpendicular E D; ſo B D will be the proper Difference of Latitude, and the Angle B, will be the Courſe; to find which, *by Calculation,*

Firſt, For the Courſe it will be (by *Caſe* 5. *of Rectangular Trigonometry*)

BE : R :: DE : S, B.

i. e. As the Diſtance - - 138 - - - 2.13988
is to Radius - - - - - - - - - - - 10.00000
ſo is the Departure - - - 112.6 - 2.05154
to the Sine of the Courſe - 54°, 41′ - - 9.91166
which, becauſe the Ship ſails between South and Eaſt, will be South 54°, 41′ Eaſt, or S E 9°, 41′ Eaſterly.

Then for the Difference of Latitude it will be (by *Caſe* 3. *of Rectangular Trigonometry*)

R : BE :: Co-S, B : BD.

i. e. As Radius - - - - - - - - - - 10.00000
is to the Diſtance - - 138 - - - - 2.13988
ſo is the Co-ſine of the Courſe 54°, 41′ - 9.76200
to the Difference of Latitude 79.8 - - 1.90188
equal to 1°, 19′. Conſequently the Ship has come to the Latitude of 47°, 14′. Hence the meridional Difference of Latitude will be 117.7.

2. Produce B to A, 'till BA be equal to 117.7, and through A draw AC parallel to DE, meeting BE produced in C; then AC will be the Difference of Longitude: To find which *by Calculation*, it will be (by *Art.* 73. *Sect.* I.)

BD : DE :: BA : AC.

i. e. As the proper Diff. of Latitude 79.8 - 1.90188
is to the Departure - - - - 112.6 - 2.05154
ſo is the enlarged Diff. of Latitude 117.7 - 2.07078
to the Diff. of Longitude - - 166.1 - 2.22044
equal

equal to 2°, 46′, 06″, the Difference of Longitude Eaſterly.

9. From what has been ſaid, it will be eaſy to ſolve a *Traverſe* according to the Rules of *Mercator's Sailing*.

Example.

Suppoſe a Ship at the *Lizard*, in the Latitude of 50°, 00′ North, is bound to the *Madeira*, in the Latitude of 32°, 20′ North, the Difference of Longitude between them being 11°, 40′, the Weſt End of the *Madeira* lying ſo much to the Weſtward of the *Lizard*, and conſequently the direct Courſe and Diſtance (by *Caſe* 2. of this *Sect.*) is South 26°, 15′ Weſt 1181.9 Miles; but by reaſon of the Winds ſhe is forced to ſail on the following Courſes (Allowance being made for Lee-way and Variation, &c.) *viz.* S S W 44 Miles, S *b* W ½ Weſt 36 Miles, S W *b* S 56 Miles, and S *b* E 28 Miles; required the Latitude the Ship is in, her Bearing and Diſtance from the *Lizard*, and her direct Courſe and Diſtance to the *Madeira*, at the End of theſe Courſes.

The *Geometrical Conſtruction* of this *Traverſe* is performed by laying down the two Ports, according to Conſtruction of *Caſe* 2. of this *Sect.* and the ſeveral Courſes and Diſtances according to *Caſe* 3. by which we have the following Solution *by Calculation.*

1. Courſe S S W, Diſtance 44 Miles.

For Difference of Latitude.

As Radius - - - - - - - - - -		10.00000
is to the Diſtance - - -	44 - - - -	1.64345

ſo is the Co-ſine of the Courſe 22°, 30′ - 9.96562
to the Diff. of Latitude - 40.65 - - 1.60907

and ſince the Courſe is Southerly, therefore the Latitude come to will be 49°, 20′ North, and conſequently the meridional Difference of Latitude will be 61.8, Then,

For Difference of Longitude,

As Radius - - - - - - - - - - - 10.00000
is to the enlarged Diff. of Lat. - 61.8 - 1.79099
ſo is the Tangent of the Courſe 22°, 30′ 9.61722
to the Min. of Difference of Long. 25.6 - 1.40821

2. Courſe S *b* W ½ Weſt, Diſtance 36 Miles.

For Difference of Latitude.

As Radius - - - - - - - - - - 10.00000
is to the Diſtance - - - 36 - - - - 1.55630
ſo is the Co-ſine of the Courſe 16°, 52′ - 9.98090
to the Diff. of Latitude - 34.46 - - 1.53720

and ſince the Courſe is Southerly, therefore the Latitude come to will be 48°, 45′. Hence the meridional Difference of Latitude will be 53.4. Then,

For Difference of Longitude,

As Radius - - - - - - - - - - 10.00000
is to the enlarged Diff. of Lat. 53.4 - - 1.72754
ſo is the Tang. of the Courſe 16°, 52′ - 9.48171
to the Difference of Longitude 16.19 - 1.20925

3. Courſe S W *b* S, Diſtance 56 Miles.

For Difference of Latitude.

As Radius - - - - - - - - - - 10.00000
is to the Diſtance - - - 56 - - - 1.74819
ſo is the Co-ſine of the Courſe 33°, 45′ - 9.91985
to the Difference of Latitude 46.56 - - 1.66804
conſequently the Latitude come to is 47°, 59′, and therefore the enlarged Difference of Latitude will be 69.2. Then

For Difference of Longitude.

As Radius - - - - - - - - - - 10.00000
is to the enlarged Diff. of Lat. - 69.2 - 1.84011
ſo is the Tang. of the Courſe 33°, 45′ 9.82489
to the Difference of Longitude 46.24 - 1.66500

4. Courſe S *b* E, Diſtance 28 Miles.

For Difference of Latitude.

As Radius - - - - - - - - - - 10.00000
is to the Diſtance - - - - 28 - - 1.44716
ſo is the Co-ſine of the Courſe 11°, 15′ 9.99157
to the Difference of Latitude 27.46 - 1.43873
conſequently the Latitude come to will be 47°, 31′, and hence the meridional Difference of Latitude will be 43.2. Then

For Difference of Longitude.

As Radius - - - - - - - - - - 10.00000
is to the enlarged Difference of Lat. 43.2 1.63458
ſo is the Tang. of the Courſe - 11°, 15′ 9.29866
to the Diff. of Longitude - - 8.59 - 0.95414

Now theſe ſeveral Courſes and Diſtances, together with the Difference of Latitude and Longitude belonging to each of them, being ſet down in their proper Columns in the *Traverſe Table*, will ſtand as follow.

Courſes.

Courſes.	*Diſtances.*	*Diff. of Lat.*		*Diff. of Longit.*	
		N.	*S.*	*E.*	*W.*
S S W	44	—	40.65	—	25.6
S *b* W ½ Weſt	36	—	34.46	—	16.19
S W *b* S	56	—	46.56		46.24
S *b* E	28	—	27.46	8.59	
		Diff. of Lat.	149.13	8.59	88.03
					8.59
				Diff. of Long.	79.44

Hence it is plain that the Ship has made of Southing 149.13 Minutes, and conſequently has come to the Latitude of 47°, 31′ North, and ſo the meridional Difference of Latitude between that and her firſt Latitude will be 226.1; and ſince ſhe has made of Difference of Longitude 79.44 Minutes Weſterly; therefore for the direct Courſe and Diſtance between the *Lizard* and the Ship it will be (by *Caſe* 2. *of this Section*)

For the direct Courſe.

As the merid. Diff. of Latitude	226.1	2.35430
is to Radius		10.00000
ſo is the Difference of Longitude	79.44	1.90004
to the Tang. of the Courſe	19°, 22′	9.54574

which, becauſe the Difference of Latitude is Southerly, and the Difference of Longitude Weſterly, will be South 19°, 22′ Weſt, or S *b* W 80°, 7′ Weſterly. Then,

For the direct Diſtance.

As Radius		10.00000
is to the proper Diff. of Lat.	149.13	2.17349
ſo is the Secant of the Courſe	19°, 22′	10.02530
to the direct Diſtance	158	2.19879

From the Latitude the Ship is in - - 47°, 31′ N.
ſubtract the Lat. of the *Madeira* - - 32 , 20 N.

and there remains - - - - - 15 , 11 N.

equal to 911 Minutes, the proper Difference of Latitude between the Ship and the *Madeira*.

Again, from the merid. Parts anſwering to the Latitude the Ship is in - - - 3248.4
Take the meridional Parts anſwering to the Latitude of the *Madeira* - - 2052.0

and there remains - - - - - 1196.4

the enlarged Difference of Latitude between the Ship and the *Maidera*.

Alſo, from the Diff. of Long. between the *Liz.* and the *Madeira* 11° 40′ W.
Take the Difference of Long. between the *Lizard* and the Ship 1 , 19 $\frac{44}{100}$ W.

and there remains - - - - - 10 , 20 $\frac{56}{100}$ W.

equal to 620.56 Minutes of Difference of Longitude between the Ship and the *Madeira* Weſterly.

Then for the direct Courſe and Diſtance between the Ship and the *Madeira*, it will be

For the direct Courſe.

As the merid. Diff. of Latitude 1196.4 - 3.07788
is to Radius - - - - - - - - - 10.00000
ſo is the Difference of Longitude 620.56 - 2.79278
to the Tang. of the Courſe - 27°, 25′ - 9.71493

For the direct Diſtance.

As Radius - - - - - - - 10.00000
is to the proper Diff. of Latitude 911 - 2.95952

ſo is the Secant of the Courſe 27°, 25′ - 10.05174
to the direct Diſtance - - 1027 - - 3.01126

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10. It is very common in working a Day's Reckoning at Sea, to find the Difference of Latitude and Departure to each Courſe and Diſtance, and adding all the Departures together, and all the Differences of Latitudes for the whole Departure and Difference of Latitude made good that Day; from thence (by *Caſe* 8. of this *Section*) to find the Difference of Longitude, *&c.* made good that Day. Now that this Method is falſe will evidently appear, if we conſider that the ſame Departure reckoned on two different Parallels, will give unequal Differences of Longitude; and conſequently, when ſeveral Departures are compounded together and reckoned on the ſame Parallel, the Difference of Longitude reſulting from that, cannot be the ſame with the Sum of the Differences of Longitude reſulting from the ſeveral Departures on different Parallels; and therefore I have choſen in the laſt *Example* of a *Traverſe*, to find the Difference of Longitude anſwering to each particular Courſe and Diſtance, the Sum of which muſt be the true Difference of Longitude made good by the Ship on theſe ſeveral Courſes and Diſtances.

11. We ſhewed at *Art.* 5. of this *Section*, how to conſtruct a *Mercator*'s *Chart*, and now we ſhall proceed to it's ſeveral Uſes, contained in the following *Problems*.

Prob. 1. Let it be required to lay down a Place upon the *Chart*, it's Latitude, and the Difference of Longitude between it and ſome known Place upon the *Chart* being given.

Example. Let the known Place be the *Lizard*, lying on the Parallel of 50°, 00′ North, and the Place to be laid down *St. Katharine*'s, on the Eaſt Coaſt of *America*, differing in Longitude from the *Lizard* 42°, 36′, lying ſo much to the Weſtward of it.

Let L repreſent the *Lizard* on the *Chart* (ſee *Plate* 1.) lying on the Parallel of 50°, 00′ North, it's Meridian A E. Set off from E upon the Equator E Q 42°, 36′, towards Q, which will reach from E to F. Through F draw the Meridian F G, and this will be the Meridian of *St. Katharine*'s; then ſet off from Q to H upon the graduated Meridian Q B, 28 Degrees; and through H draw the Parallel of Latitude H M, which will meet the former Meridian in K, the Place upon the *Chart* required.

Prob. 2. Given two Places upon the *Chart*, to find their Difference of Latitude and Difference of Longitude.

Through the two Places draw Parallels of Latitude; then the Diſtance between theſe Parallels, numbered in Degrees and Minutes upon the graduated Meridian, will be the Difference of Latitude required; and thro' the two Places drawing Meridians, the Diſtance between theſe, counted in Degrees and Minutes on the Equator, or any graduated Parallel, will be the Difference of Longitude required.

Prob. 3. To find the Bearing of one Place from another upon the *Chart*.

Example. Required the Bearing of *St. Katharine*'s at K (ſee *Plate* 1.) from the *Lizard* at L.

Draw the Meridian of the *Lizard* A E, and join K and L with the right Line K L, then by the Line of Chords meaſuring the Angle K L E, and with that entering the Table at *Page* 156, we ſhall have the Thing required.

This may alſo be done, by having Compaſſes drawn on the *Chart* (ſuppoſe at two of it's Corners) then lay the Edge of a Ruler over the two Places, and let fall a Perpendicular, or take the neareſt Diſtance, from the Center of the Compaſs next the firſt Place, to the Ruler's Edge; then with this Diſtance in your Compaſſes, ſlide them along by the Ruler's Edge, keeping one Foot of them cloſe to the Ruler, and the other as near as you can judge perpendicular to it, which will deſcribe the Rumb required.

Prob. 4. To find the Diſtance between two given Places upon the *Chart.*

This *Problem* admits of four *Caſes*, according to the Situation of the two Places with reſpect to one another.

Caſe 1. When the given Places lie both upon the Equator.

In this *Caſe* their Diſtance is found by converting the Degrees of Difference of Longitude intercepted between them into Minutes.

Caſe 2. When the two Places lie both on the ſame Meridian.

Draw the Parallels of thoſe Places and the Degrees, upon the graduated Meridian, intercepted between thoſe Parallels, reduced to Minutes, give the Diſtance required.

Caſe 3. When the two Places lie on the ſame Parallel.

Example. Required to find the Diſtance between the Points K and N (ſee *Plate* 1.) both lying on the Parallel of 28°, 00′ North. Take from your Scale the Chord of 60°, or Radius, in your Compaſſes, and with that Extent on K N as a Baſe, make the *Iſoſceles* Triangle K P N; then take from the Line of Sines the Co-ſine of the Latitude, or Sine of 62°, and ſet that off from P to S and T. Join S and T with the right Line S T, and that applied to the graduated Equator, will give the Degrees and Minutes upon it equal to the Diſtance; which, converted into Minutes, will be the Diſtance required.

The Reaſon of this is evident from *Sect.* VIII. for it has been there demonſtrated, that Radius is to the Co-ſine of any Parallel, as the Length of any Arch on the Equator to the Length of the ſame Arch on that Parallel: Now in this *Chart* K N is the Diſtance of the Meridians of the two Places K and N upon the Equator, and ſince in the Triangle PNK, ST is parallel to KN, therefore PN : PT :: NK : TS. Conſequently TS will be the Diſtance of the two Places K and N upon the Parallel of 28°.

If the Parallel the two Places lie on be not far from the Equator, and they not far aſunder, then their Diſtance may be found thus: Take the Diſtance between them in your Compaſſes, and apply that to the graduated Meridian, ſo as one Foot may be as many Minutes above, as the other is below the given Parallel, and the Degrees and Minutes intercepted, reduced to Minutes, will give the Diſtance.

Or it may alſo be found thus: Take the Length of a Degree on the Meridian at the given Parallel, and turn that over on the Parallel from the one Place to the other, as often as you can; then as often as that Extent is contained between the Places, ſo many Times 60 Miles will be contained in the Diſtance between them.

Caſe 4. When the Places differ both in Longitude and Latitude.

Example. Suppoſe it were required to find the Diſtance between the two Places *a* and *e* upon the *Chart.* By

Prob. 2. Find the Difference of Latitude between them, and take that in your Compaſſes from the graduated Equator, which ſet off on the Meridian of *a*, from *a* to *b*; then thro' *b* draw *bc* parallel to *de*, and taking *ac* in your Compaſſes, apply it to the graduated Equator, and it will ſhew the Degrees and Minutes contained in the Diſtance required, which multiplied by 60, will give the Miles of Diſtance.

The Reaſon of this is evident from *Art.* 8. of this *Sect.* for it is plain *ad* is the enlarged Difference of Latitude, and *ab* the proper; conſequently *ae* the enlarged Diſtance, and *ac* the proper.

Prob. 5. To lay down a Place upon the *Chart*, it's Latitude and Bearing from ſome known Place upon the *Chart* being known; or (which is the ſame) having the Courſe and Difference of Latitude that a Ship has made, to lay down the Running of the Ship, and find her Place upon the *Chart*.

Example. A Ship from the *Lizard* in the Latitude of 50°, 00′ North, ſails S S W 'till ſhe has differed her Latitude 36°, 40′. Required her Place upon the *Chart*.

Count from the *Lizard* at L, on the graduated *Meridian* downwards (becauſe the Courſe is Southerly) 36°, 40′ to *g*; through which draw a Parallel of Latitude, which will be the Parallel the Ship is in; then from L draw a S S W Line L *f*, cutting the former Parallel in *f*, and this will be the Ship's Place upon the *Chart*.

Prob. 6. One Latitude, Courſe, and Diſtance, ſailed, given, to lay down the Running of the Ship, and find her Place upon the *Chart*.

Example. Suppoſe a Ship at *a* in the Latitude of 20°, 00′ North, ſails North 37°, 20′, Eaſt 191 Miles: Required the Ship's Place upon the *Chart*.

Having drawn the Meridian and Parallel of the Place *a*, ſet off the Rumb Line *a e*, making with *a b* an Angle of 37°, 20′, and upon it ſet off 191 from *a* to *c*; thro' *c* draw the Parallel *c b*, and taking *a b* in your Compaſſes, apply it to the graduated Equator, and obſerve the Number of Degrees it contains; then count the ſame Number of Degrees on the graduated Meridian from C to *b*, and thro' *b* draw the Parallel *b e*, which will cut *a c* produced in the Point *e*, the Ship's Place required.

Prob. 7. Both Latitudes and Diſtance ſailed, given, to find the Ship's Place upon the *Chart*.

Example. Suppoſe a Ship ſails from *a*, in the Latitude of 20°, 00′ North, between North and Eaſt 191

Miles, and is then in the Latitude of 45°, 00′ North; required the Ship's Place upon the *Chart*.

Draw *d e* the Parallel of 45°, and ſet off upon the Meridian of *a* upwards, *a b* equal to the proper Difference of Latitude taken from the Equator or graduated Parallel. Thro' *b* draw *b c* parallel to *d e*; then with 191 in your Compaſſes, fixing one Foot of them in *a* with the other croſs *b e* in *c*. Join *a* and *c* with the right Line *a c*, which produced will meet *d e* in *e*, the Ship's Place required.

Prob. 8. One Latitude, Courſe, and Difference of Longitude given, to find the Ship's Place upon the *Chart*.

Example. Suppoſe a Ship from the *Lizard* in the Latitude of 50°, 00′ North, ſails S W *b* W, 'till her Difference of Longitude is 42°, 36′; required the Ship's Place upon the *Chart*.

Having drawn A E the Meridian of the *Lizard* at L, count from E to F upon the Equator 42°, 36′, and thro' F draw the Meridian F G; then from L draw the S W *b* W Line L K, and where this meets F G, as at K, will be the Ship's Place required.

Prob. 9. One Latitude, Courſe, and Departure given, to find the Ship's Place upon the *Chart*.

Example. Suppoſe a Ship at *a* in the Latitude of 20°, 00′ North, ſails North 37°, 23′ Eaſt, 'till ſhe has made of Departure 116 Miles; required the Ship's Place upon the *Chart*.

Having drawn the Meridian of *a*, at the Diſtance of 116, draw parallel to it the Meridian *k l*. Draw the Rumb Line *a c*, which will meet *k l* in ſome Point *c*; then thro' *c* draw the Parallel *c b*, and *a b* will be the proper Difference of Latitude, and *b c* the Departure. Take *a b* in your Compaſſes, and apply it to the Equator or graduated Parallel; then obſerve the Number of Degrees it contains, and count ſo many on the graduated Meridian from C upwards to *b*. Thro' *b* draw the Parallel *b e*, which will meet *a c* produced in ſome Point as *e*, which is the Ship's Place upon the *Chart.*

Prob. 10. One Latitude, Diſtance, and Departure given, to find the Ship's Place upon the *Chart.*

Example. Suppoſe a Ship at *a*, in the Latitude of 20°, 00′ North, ſails 191 Miles between North and Eaſt, and then is found to have made of Departure 116 Miles; required the Ship's Place upon the *Chart.*

Having drawn the Meridian and Parallel of the Place *a*, ſet off upon the Parallel *a m* equal to 116, and thro' *m* draw the Meridian *k l*; take the given Diſtance 191 in your Compaſſes, ſetting one Foot of them in *a*, with the other croſs *k l* in *c*, join *a c*, and thro' *c* draw the Parallel *c b*; ſo *c b* will be the Departure, and *a b* the proper Difference of Latitude; then proceeding with this as in the foregoing *Problem*, you will find the Ship's Place to be *e*.

Prob. 11. The Latitude ſailed from, Difference of Latitude and Departure given, to find the Ship's Place upon the *Chart.*

Example. Suppoſe a Ship from *a* in the Latitude of 20°, 00′ North, ſails between North and Eaſt, 'till ſhe be in the Latitude of 45°, 00′ North, and is then found to have made of Departure 116 Miles; required the Ship's Place upon the *Chart.*

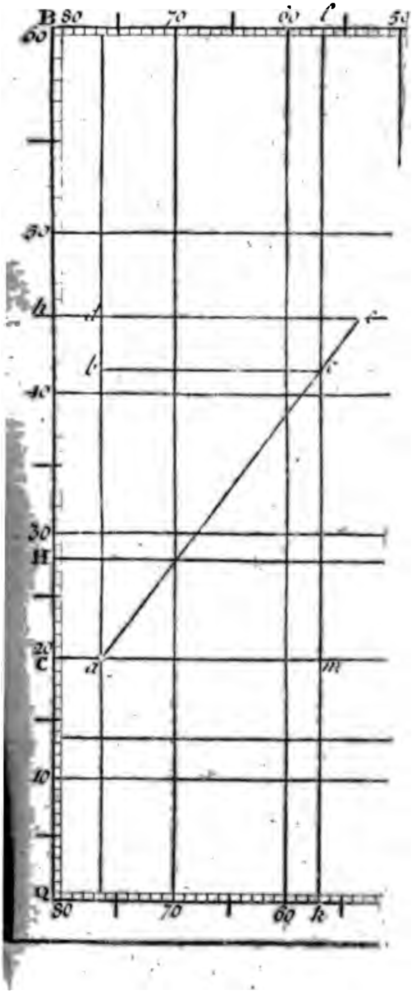
Having drawn the Meridian of *a*, ſet off upon it from *a* to *b* 25 Degrees (taken from the Equator or graduated Parallel) the proper Difference of Latitude; then thro' *b* draw the Parallel *b c*, and make *b c* equal to 116, the Departure, and join *a c*. Count from the Parallel of *a* on the graduated Meridian upwards to *b* 25 Degrees, and thro' *b* draw the Parallel *b e*, which will meet *a c* produced in ſome Point *e*, and this will be the Place of the Ship required.

12. In *Sect.* VII. 'tis plain, that the Terms *Meridional Diſtance*, *Departure*, and *Difference of Longitude*, were ſynonymous, conſtantly ſignifying the ſame Thing; which evidently followed from the Suppo-

ſition of the Earth's Surface being projected on a Plane, in which the Meridians were made parallel, and the Degrees of Latitude equal to one another, and to thoſe of the Equator. But ſince it has been demonſtrated (in this *Section*) that if, in the Projection of the Earth's Surface upon a Plane, the *Meridians* be made parallel, the Degrees of Latitude muſt be unequal, ſtill increaſing the nearer they come to the *Pole*; it follows, that theſe Terms muſt denote Lines really different from one another. *Difference of Longitude* is defined at *Art.* 14. *Sect.* III. *Meridional Diſtance* at *Art.* 3. *Sect.* VII. and *Departure* at *Art.* 8. of this *Section.*

A TABLE

Plate 1.



A

TABLE

OF

MERIDIONAL PARTS.

L.	0	1	2	3	4	5	6	7	8
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	.0	60.0	120.0	180.1	240.2	300.4	360.7	421.1	481.6
1	1.0	61.0	121.0	181.1	241.2	301.4	361.7	422.1	482.6
2	2.0	62.0	122.0	182.1	242.2	302.4	362.7	423.1	483.6
3	3.0	63.0	123.0	183.1	243.2	303.4	363.7	424.1	484.6
4	4.0	64.0	124.0	184.1	244.2	304.4	364.7	425.1	485.6
5	5.0	65.0	125.0	185.1	245.2	305.4	365.7	426.1	486.6
6	6.0	66.0	126.0	186.1	246.2	306.4	366.7	427.1	487.6
7	7.0	67.0	127.0	187.1	247.2	307.4	367.7	428.1	488.6
8	8.0	68.0	128.0	188.1	248.2	308.4	368.7	429.1	489.6
9	9.0	69.0	129.0	189.1	249.2	309.4	369.7	430.1	490.7
10	10.0	70.0	130.0	190.1	250.2	310.4	370.7	431.1	491.7
11	11.0	71.0	131.0	191.1	251.2	311.4	371.7	432.1	492.7
12	12.0	72.0	132.0	192.1	252.2	312.4	372.7	433.1	493.7
13	13.0	73.0	133.0	193.1	253.2	313.4	373.7	434.2	494.7
14	14.0	74.0	134.0	194.1	254.2	314.4	374.7	435.2	495.7
15	15.0	75.0	135.0	195.1	255.2	315.4	375.8	436.2	496.7
16	16.0	76.0	136.0	196.1	256.2	316.5	376.8	437.2	497.7
17	17.0	77.0	137.0	197.1	257.2	317.5	377.8	438.2	498.7
18	18.0	78.0	138.0	198.1	258.2	318.5	378.8	439.2	499.8
19	19.0	79.0	139.0	199.1	259.3	319.5	379.8	440.2	500.8
20	20.0	80.0	140.0	200.1	260.3	320.5	380.8	441.2	501.8
21	21.0	81.0	141.0	201.1	261.3	321.5	381.8	442.2	502.8
22	22.0	82.0	142.0	202.1	262.3	322.5	382.8	443.2	503.8
23	23.0	83.0	143.0	203.1	263.3	323.5	383.8	444.2	504.8
24	24.0	84.0	144.0	204.1	264.3	324.5	384.8	445.2	505.8
25	25.0	85.0	145.0	205.1	265.3	325.5	385.8	446.3	506.8
26	26.0	86.0	146.0	206.1	266.3	326.5	386.8	447.3	507.8
27	27.0	87.0	147.0	207.1	267.3	327.5	387.8	448.3	508.9
28	28.0	88.0	148.1	208.1	268.3	328.5	388.8	449.3	509.9
29	29.0	89.0	149.1	209.1	269.3	329.5	389.8	450.3	510.9
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	0	1	2	3	4	5	6	7	8

L.	0	1	2	3	4	5	6	7	8
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	30.0	90.0	150.1	210.1	270.3	330.5	390.8	451.3	511.9
31	31.0	91.0	151.1	211.1	271.3	331.5	391.9	452.3	512.9
32	32.0	92.0	152.1	212.1	272.3	332.5	392.9	453.3	513.9
33	33.0	93.0	153.1	213.1	273.3	333.5	393.9	454.3	514.9
34	34.0	94.0	154.1	214.1	274.3	334.5	394.9	455.3	515.9
35	35.0	95.0	155.1	215.1	275.3	335.5	395.9	456.3	516.9
36	36.0	96.0	156.1	216.1	276.3	336.5	396.9	457.3	518.0
37	37.0	97.0	157.1	217.1	277.3	337.5	397.9	458.4	519.0
38	38.0	98.0	158.1	218.2	278.3	338.6	398.9	459.4	520.0
39	39.0	99.0	159.1	219.2	279.3	339.6	399.9	460.4	521.0
40	40.0	100.0	160.1	220.2	280.3	340.6	400.9	461.4	522.0
41	41.0	101.0	161.1	221.2	281.3	341.6	401.9	462.4	523.0
42	42.0	102.0	162.1	222.2	282.3	342.6	402.9	463.4	524.0
43	43.0	103.0	163.1	223.2	283.3	343.6	403.9	464.4	525.0
44	44.0	104.0	164.1	224.2	284.3	344.6	404.9	465.4	526.0
45	45.0	105.0	165.1	225.2	285.3	345.6	405.9	466.4	527.1
46	46.0	106.0	166.1	226.2	286.3	346.6	407.0	467.4	528.1
47	47.0	107.0	167.1	227.2	287.3	347.6	408.0	468.4	529.1
48	48.0	108.0	168.1	228.2	288.3	348.6	409.0	469.5	530.1
49	49.0	109.0	169.1	229.2	289.3	349.6	410.0	470.5	531.1
50	50.0	110.0	170.1	230.2	290.3	350.6	411.0	471.5	532.1
51	51.0	111.0	171.1	231.2	291.4	351.6	412.0	472.5	533.1
52	52.0	112.0	172.1	232.2	292.4	352.6	413.0	473.5	534.1
53	53.0	113.0	173.1	233.2	293.4	353.6	414.0	474.5	535.1
54	54.0	114.0	174.1	234.2	294.4	354.6	415.0	475.5	536.2
55	55.0	115.0	175.1	235.2	295.4	355.6	416.0	476.5	537.2
56	56.0	116.0	176.1	236.2	296.4	356.6	417.0	477.5	538.2
57	57.0	117.0	177.1	237.2	297.4	357.6	418.0	478.5	539.2
58	58.0	118.0	178.1	238.2	298.4	358.7	419.0	479.6	540.2
59	59.0	119.0	179.1	239.2	299.4	359.7	420.0	480.6	541.2
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	0	1	2	3	4	5	6	7	8

L.	9	10	11	12	13	14	15	16
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	542.2	603.1	664.1	725.3	786.8	848.5	910.5	972.8
1	543.3	604.1	665.1	726.4	787.9	849.5	911.5	973.8
2	544.3	605.1	666.1	727.4	788.9	850.6	912.6	974.8
3	545.3	606.1	667.1	728.4	789.9	851.6	913.6	975.9
4	546.3	607.1	668.1	729.4	790.9	852.6	914.6	976.9
5	547.3	608.2	669.2	730.5	792.0	853.7	915.7	978.0
6	548.3	609.2	670.2	731.5	793.0	854.7	916.7	979.0
7	549.3	610.2	671.2	732.5	794.0	855.7	917.7	980.0
8	550.3	611.2	672.2	733.5	795.0	856.8	918.8	981.1
9	551.4	612.2	673.2	734.6	796.1	857.8	919.8	982.1
10	552.4	613.2	674.3	735.6	797.1	858.9	920.8	983.2
11	553.4	614.2	675.3	736.6	798.1	859.9	921.9	984.2
12	554.4	615.3	676.3	737.6	799.1	861.0	922.9	985.2
13	555.4	616.3	677.3	738.7	800.2	862.0	923.9	986.3
14	556.4	617.3	678.3	739.7	801.2	863.0	925.0	987.3
15	557.4	618.3	679.4	740.7	802.2	864.1	926.0	988.4
16	558.4	619.3	680.4	741.7	803.2	865.1	927.0	989.4
17	559.4	620.3	681.4	742.8	804.3	866.1	928.1	990.4
18	560.5	621.3	682.4	743.8	805.3	867.2	929.1	991.5
19	561.5	622.4	683.4	744.8	806.3	868.2	930.1	992.5
20	562.5	623.4	684.5	745.8	807.3	869.2	931.2	993.6
21	563.5	624.4	685.5	746.9	808.4	870.3	932.2	994.6
22	564.5	625.4	686.5	747.9	809.4	871.3	933.2	995.6
23	565.5	626.4	687.5	748.9	810.4	872.3	934.3	996.7
24	566.6	627.4	688.5	749.9	811.4	873.4	935.3	997.7
25	567.6	628.5	689.6	751.0	812.5	874.4	936.3	998.8
26	568.6	629.5	690.6	752.0	813.5	875.4	937.4	999.8
27	569.6	630.5	691.6	753.0	814.5	876.5	938.4	1000.8
28	570.6	631.5	692.6	754.0	815.5	877.5	939.4	1001.9
29	571.6	632.5	693.6	755.1	816.6	878.5	940.5	1002.9
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	9	10	11	12	13	14	15	16

L.	9	10	11	12	13	14	15	16
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	572.6	633.5	694.7	756.1	817.6	879.6	941.5	1004.0
31	573.7	634.6	695.7	757.1	818.6	880.6	942.5	1005.0
32	574.7	635.6	696.7	758.1	819.6	881.6	943.6	1006.1
33	575.7	636.6	697.7	759.2	820.7	882.7	944.6	1007.1
34	576.7	637.6	698.7	760.2	821.7	883.7	945.6	1008.1
35	577.7	638.6	699.8	761.2	822.7	884.7	946.7	1009.2
36	578.7	639.6	700.8	762.2	823.7	885.8	947.7	1010.2
37	579.7	640.6	701.8	763.3	824.8	886.8	948.7	1011.3
38	580.8	641.7	702.8	764.3	825.8	887.8	949.8	1012.3
39	581.8	642.7	703.8	765.3	826.8	888.9	950.8	1013.4
40	582.8	643.7	704.9	766.3	827.9	889.9	951.9	1014.4
41	583.8	644.7	705.9	767.4	828.9	890.9	952.9	1015.4
42	584.8	645.7	706.9	768.4	829.9	892.0	953.9	1016.5
43	585.8	646.7	707.9	769.4	831.0	893.0	955.0	1017.5
44	586.8	647.7	708.9	770.4	832.0	894.0	956.0	1018.6
45	587.9	648.8	710.0	771.5	833.0	895.1	957.1	1019.6
46	588.9	649.8	711.0	772.5	834.1	896.1	958.1	1020.6
47	589.9	650.8	712.0	773.5	835.1	897.1	959.2	1021.7
48	590.9	651.8	713.0	774.5	836.1	898.2	960.2	1022.7
49	591.9	652.8	714.1	775.6	837.2	899.2	961.3	1023.8
50	592.9	653.9	715.1	776.6	838.2	900.2	962.3	1024.8
51	593.9	654.9	716.1	777.6	839.2	901.2	963.4	1025.9
52	595.0	655.9	717.1	778.6	840.3	902.3	964.4	1026.9
53	596.0	656.9	718.2	779.7	841.3	903.3	965.5	1028.0
54	597.0	657.9	719.2	780.7	842.3	904.3	966.5	1029.0
55	598.0	659.0	720.2	781.7	843.4	905.4	967.6	1030.1
56	599.0	660.0	721.2	782.7	844.4	906.4	968.6	1031.1
57	600.0	661.0	722.3	783.8	845.4	907.4	969.6	1032.2
58	601.0	662.0	723.3	784.8	846.5	908.4	970.7	1033.2
59	602.1	663.0	724.3	785.8	847.5	909.5	971.7	1034.3
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	9	10	11	12	13	14	15	16

L.	17	18	19	20	21	22	23
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	1035.3	1098.2	1161.5	1225.1	1289.2	1353.7	1418.7
1	1036.3	1099.3	1162.5	1226.2	1290.2	1354.8	1419.7
2	1037.4	1100.3	1163.6	1227.3	1291.3	1355.8	1420.8
3	1038.4	1101.4	1164.7	1228.3	1292.4	1356.9	1421.9
4	1039.5	1102.4	1165.7	1229.4	1293.5	1358.0	1423.0
5	1040.5	1103.5	1166.8	1230.4	1294.5	1359.0	1424.1
6	1041.6	1104.5	1167.8	1231.5	1295.6	1360.1	1425.1
7	1042.6	1105.6	1168.9	1232.6	1296.7	1361.2	1426.2
8	1043.7	1106.6	1170.0	1233.6	1297.8	1362.3	1427.3
9	1044.7	1107.7	1171.0	1234.7	1298.8	1363.3	1428.4
10	1045.8	1108.7	1172.1	1235.8	1299.9	1364.4	1429.5
11	1046.8	1109.8	1173.1	1236.8	1301.0	1365.5	1430.6
12	1047.9	1110.8	1174.2	1237.9	1302.0	1366.6	1431.7
13	1048.9	1111.9	1175.2	1239.9	1303.1	1367.6	1432.8
14	1049.9	1112.9	1176.3	1240.0	1304.2	1368.7	1433.9
15	1051.0	1114.0	1177.4	1241.1	1305.3	1369.8	1434.9
16	1052.0	1115.0	1178.4	1242.2	1306.3	1370.9	1436.0
17	1053.1	1116.1	1179.5	1243.2	1307.4	1372.0	1437.1
18	1054.1	1117.1	1180.5	1244.3	1308.5	1373.1	1438.2
19	1055.2	1118.2	1181.6	1245.4	1309.6	1374.2	1439.5
20	1056.2	1119.2	1182.7	1246.4	1310.6	1375.3	1440.4
21	1057.3	1120.3	1183.7	1247.5	1311.7	1376.4	1441.5
22	1058.3	1121.3	1184.8	1248.6	1312.8	1377.4	1442.6
23	1059.3	1122.4	1185.8	1249.6	1313.8	1378.5	1443.7
24	1060.4	1123.4	1186.9	1250.7	1314.9	1379.6	1444.8
25	1061.4	1124.5	1188.0	1251.8	1316.0	1380.7	1445.8
26	1062.5	1125.5	1189.0	1252.8	1317.1	1381.8	1446.9
27	1063.5	1126.6	1190.1	1253.9	1318.1	1382.8	1448.0
28	1064.6	1127.6	1191.1	1255.0	1319.2	1383.9	1449.1
29	1065.6	1128.7	1192.2	1256.0	1320.3	1385.0	1450.2
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	17	18	19	20	21	22	23

L.	17	18	19	20	21	22	23
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	1066.7	1129.7	1193.2	1257.1	1321.4	1386.1	1451.3
31	1067.7	1130.8	1194.3	1258.2	1322.4	1387.2	1452.4
32	1068.8	1131.8	1195.4	1259.2	1323.5	1388.3	1453.5
33	1069.8	1132.9	1196.4	1260.3	1324.6	1389.4	1454.6
34	1070.9	1134.0	1197.5	1261.4	1325.7	1390.4	1455.7
35	1072.0	1135.1	1198.5	1262.4	1326.7	1391.5	1456.8
36	1073.0	1136.1	1199.6	1263.5	1327.8	1392.6	1457.9
37	1074.1	1137.2	1200.7	1264.6	1328.9	1393.7	1458.9
38	1075.1	1138.2	1201.7	1265.6	1330.0	1394.8	1460.0
39	1076.2	1139.3	1202.8	1266.7	1331.0	1395.8	1461.1
40	1077.2	1140.3	1203.9	1267.8	1332.1	1396.9	1462.2
41	1078.3	1141.4	1204.9	1268.8	1333.2	1398.0	1463.3
42	1079.4	1142.4	1206.0	1269.9	1334.2	1399.1	1464.4
43	1080.4	1143.5	1207.1	1271.0	1335.3	1400.2	1465.5
44	1081.4	1144.6	1208.1	1272.1	1336.4	1401.3	1466.6
45	1082.5	1145.6	1209.2	1273.1	1337.5	1402.4	1467.7
46	1083.5	1146.7	1210.2	1274.2	1338.6	1403.4	1468.8
47	1084.6	1147.7	1211.3	1275.3	1339.7	1404.5	1469.8
48	1085.6	1148.8	1212.4	1276.3	1340.7	1405.6	1470.9
49	1086.7	1149.8	1213.4	1277.4	1341.8	1406.7	1472.0
50	1087.7	1150.9	1214.5	1278.5	1342.9	1407.8	1473.1
51	1088.8	1152.0	1215.5	1279.5	1344.0	1408.8	1474.2
52	1089.8	1153.0	1216.6	1280.6	1345.0	1409.9	1475.3
53	1090.9	1154.1	1217.7	1281.7	1346.1	1411.0	1476.4
54	1091.9	1155.1	1218.7	1282.7	1347.2	1412.1	1477.5
55	1093.0	1156.2	1219.8	1283.8	1348.3	1413.2	1478.6
56	1094.0	1157.2	1220.9	1284.9	1349.4	1414.3	1479.7
57	1095.1	1158.3	1221.9	1286.0	1350.4	1415.4	1480.8
58	1096.1	1159.4	1223.0	1287.0	1351.5	1416.5	1481.9
59	1097.2	1160.4	1224.1	1288.1	1352.6	1417.6	1483.0
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	17	18	19	20	21	22	23

L.	24	25	26	27	28	29	30
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	1484.1	1550.0	1616.5	1683.6	1751.2	1819.5	1888.4
1	1485.2	1551.1	1617.6	1684.7	1752.3	1820.6	1889.5
2	1486.3	1552.2	1618.7	1685.8	1753.4	1821.7	1890.7
3	1487.3	1553.3	1619.8	1686.9	1754.6	1822.9	1891.9
4	1488.4	1554.4	1620.9	1688.0	1755.7	1824.0	1893.0
5	1489.5	1555.5	1622.0	1689.1	1756.8	1825.2	1894.2
6	1490.6	1556.6	1623.2	1690.3	1758.0	1826.3	1895.3
7	1491.7	1557.7	1624.3	1691.4	1759.1	1827.5	1896.5
8	1492.8	1558.8	1625.4	1692.5	1760.2	1828.6	1897.6
9	1493.9	1559.9	1626.5	1693.6	1761.4	1829.7	1898.8
10	1495.0	1561.0	1627.6	1694.8	1762.5	1830.9	1899.9
11	1496.1	1562.1	1628.7	1695.9	1763.6	1832.0	1901.1
12	1497.2	1563.2	1629.8	1697.0	1764.8	1833.2	1902.3
13	1498.3	1564.3	1631.0	1698.1	1765.9	1834.3	1903.4
14	1499.4	1565.4	1632.1	1699.3	1767.0	1835.5	1904.6
15	1500.5	1566.5	1633.2	1700.4	1768.2	1836.6	1905.7
16	1501.6	1567.6	1634.3	1701.5	1769.3	1837.8	1906.9
17	1502.7	1568.7	1635.4	1702.6	1770.5	1838.9	1908.1
18	1503.8	1569.8	1636.5	1703.8	1771.6	1840.1	1909.2
19	1504.9	1571.0	1637.7	1704.9	1772.7	1841.2	1910.4
20	1506.0	1572.1	1638.8	1706.0	1773.9	1842.4	1911.5
21	1507.1	1573.2	1639.9	1707.1	1775.0	1843.5	1912.7
22	1508.2	1574.3	1641.0	1708.3	1776.1	1844.6	1913.8
23	1509.3	1575.4	1642.1	1709.4	1777.2	1845.8	1915.0
24	1510.4	1576.5	1643.2	1710.5	1778.4	1846.9	1916.2
25	1511.5	1577.6	1644.3	1711.6	1779.5	1848.1	1917.3
26	1512.6	1578.7	1645.5	1712.8	1780.6	1849.2	1918.5
27	1513.7	1579.8	1646.6	1713.9	1781.8	1850.4	1919.6
28	1514.8	1580.9	1647.7	1715.0	1783.0	1851.5	1920.8
29	1515.9	1582.0	1648.8	1716.1	1784.1	1852.7	1921.9
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	24	25	26	27	28	29	30

L.	24	25	26	27	28	29	30
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	1517.0	1583.2	1649.9	1717.8	1785.2	1853.9	1923.1
31	1518.1	1584.3	1651.0	1718.4	1786.4	1855.0	1924.3
32	1519.2	1585.4	1652.2	1719.5	1787.5	1856.1	1925.4
33	1520.3	1586.5	1653.3	1720.7	1788.6	1857.2	1926.6
34	1521.4	1587.6	1654.4	1721.8	1789.8	1858.4	1927.8
35	1522.5	1588.7	1655.5	1722.9	1790.9	1859.6	1928.9
36	1523.5	1589.8	1656.6	1724.0	1792.1	1860.7	1930.1
37	1524.7	1590.9	1657.8	1725.2	1793.2	1861.9	1931.3
38	1525.8	1592.0	1658.9	1726.3	1794.3	1863.0	1932.4
39	1526.9	1593.2	1660.0	1727.4	1795.5	1864.2	1933.6
40	1528.0	1594.2	1661.1	1728.6	1796.6	1865.3	1934.7
41	1529.1	1595.4	1662.2	1729.7	1797.8	1866.5	1935.9
42	1530.2	1596.5	1663.4	1730.8	1798.9	1867.6	1937.1
43	1531.3	1597.6	1664.5	1731.9	1800.0	1868.8	1938.2
44	1532.4	1598.7	1665.6	1733.1	1801.2	1869.9	1939.4
45	1533.5	1599.8	1666.7	1734.2	1802.3	1871.1	1940.5
46	1534.6	1600.9	1667.8	1735.3	1803.5	1872.2	1941.7
47	1535.7	1602.0	1669.0	1736.6	1804.6	1873.4	1942.9
48	1536.8	1603.1	1670.1	1737.6	1805.7	1874.5	1944.0
49	1537.9	1604.3	1671.2	1738.7	1806.9	1875.7	1945.2
50	1539.0	1605.4	1672.3	1739.9	1808.0	1876.8	1946.4
51	1540.1	1606.5	1673.4	1741.0	1809.2	1878.0	1947.5
52	1541.2	1607.6	1674.6	1742.1	1810.3	1879.2	1948.7
53	1542.3	1608.7	1675.7	1743.2	1811.4	1880.3	1949.9
54	1543.4	1609.8	1676.9	1744.4	1812.6	1881.5	1951.0
55	1544.5	1610.9	1678.0	1745.5	1813.7	1882.6	1952.2
56	1545.6	1612.0	1679.1	1746.6	1814.9	1883.8	1953.4
57	1546.7	1613.1	1680.2	1747.8	1816.0	1884.9	1954.5
58	1547.8	1614.3	1681.3	1748.9	1817.2	1886.1	1955.7
59	1548.9	1615.4	1682.4	1750.0	1818.3	1887.2	1956.9
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	24	25	26	27	28	29	30

L.	31	32	33	34	35	36	37
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	1958.1	2028.4	2099.6	2171.5	2244.3	2318.0	2392.7
1	1959.2	2029.6	2100.7	2172.7	2245.5	2319.3	2393.9
2	1960.4	2030.7	2101.9	2173.9	2246.8	2320.5	2395.2
3	1961.5	2031.9	2103.1	2175.1	2248.0	2321.7	2396.4
4	1962.7	2033.1	2104.3	2176.3	2249.2	2323.0	2397.7
5	1963.9	2034.3	2105.5	2177.5	2250.4	2324.2	2398.9
6	1965.0	2035.5	2106.7	2178.7	2251.6	2325.4	2400.2
7	1966.2	2036.7	2107.9	2180.0	2252.9	2326.7	2401.4
8	1967.4	2037.8	2109.1	2181.2	2254.1	2327.9	2402.7
9	1968.5	2039.0	2110.3	2182.4	2255.3	2329.2	2403.9
10	1969.7	2040.2	2111.5	2183.6	2256.5	2330.4	2405.2
11	1970.9	2041.4	2112.7	2184.8	2257.8	2331.6	2406.4
12	1972.0	2042.6	2113.9	2186.0	2259.0	2332.9	2407.7
13	1973.2	2043.8	2115.1	2187.2	2260.2	2334.1	2409.0
14	1974.4	2044.9	2116.3	2188.4	2261.4	2335.3	2410.2
15	1975.6	2046.1	2117.5	2189.6	2262.7	2336.6	2411.5
16	1976.8	2047.3	2118.7	2190.8	2263.9	2337.8	2412.7
17	1977.9	2048.5	2119.8	2192.0	2265.1	2339.0	2414.0
18	1979.1	2049.7	2121.0	2193.3	2266.3	2340.3	2415.2
19	1980.3	2050.8	2122.2	2194.4	2267.6	2341.5	2416.5
20	1981.4	2052.0	2123.4	2195.7	2268.8	2342.8	2417.8
21	1982.6	2053.2	2124.6	2196.9	2270.0	2344.0	2419.0
22	1983.7	2054.4	2125.8	2198.1	2271.2	2345.3	2420.3
23	1984.9	2055.6	2127.0	2199.3	2272.5	2346.5	2421.3
24	1986.1	2056.8	2128.2	2200.5	2273.7	2347.8	2422.8
25	1987.3	2058.0	2129.4	2201.7	2274.9	2349.0	2424.0
26	1988.4	2059.1	2130.6	2203.0	2276.1	2350.2	2425.5
27	1989.6	2060.3	2131.8	2204.2	2277.4	2351.5	2426.5
28	1990.8	2061.5	2133.0	2205.4	2278.6	2352.7	2427.8
29	1992.0	2062.7	2134.2	2206.6	2279.8	2354.0	2429.1
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	31	32	33	34	35	36	37

L.	31	32	33	34	35	36	37
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	1993.1	2063.9	2135.4	2207.8	2281.0	2355.2	2430.3
31	1994.3	2065.1	2136.6	2209.0	2282.3	2356.5	2431.6
32	1995.5	2066.2	2137.8	2210.2	2283.5	2357.7	2432.9
33	1996.6	2067.4	2139.0	2211.4	2284.7	2358.9	2434.1
34	1997.8	2068.6	2140.2	2212.7	2286.0	2360.2	2435.4
35	1999.0	2069.8	2141.4	2213.9	2287.2	2361.4	2436.7
36	2000.2	2071.0	2142.6	2215.1	2288.4	2362.7	2437.9
37	2001.3	2072.2	2143.8	2216.3	2289.7	2363.9	2439.2
38	2002.5	2073.4	2145.0	2217.5	2290.9	2365.2	2440.4
39	2003.7	2074.6	2146.2	2218.7	2292.1	2366.4	2441.7
40	2004.9	2075.7	2147.4	2219.9	2293.3	2367.7	2443.0
41	2006.0	2076.9	2148.6	2221.2	2294.6	2368.9	2444.2
42	2007.2	2078.1	2149.8	2222.4	2295.8	2370.2	2445.5
43	2008.4	2079.3	2151.0	2223.6	2297.0	2371.4	2446.8
44	2009.6	2080.5	2152.2	2224.8	2298.3	2372.7	2448.0
45	2010.7	2081.7	2153.4	2226.0	2299.5	2373.9	2449.3
46	2011.9	2082.9	2154.6	2227.2	2300.7	2375.2	2450.6
47	2013.1	2084.1	2155.8	2228.5	2302.0	2376.4	2451.8
48	2014.3	2085.3	2157.0	2229.7	2303.2	2377.7	2453.1
49	2015.4	2086.5	2158.2	2230.9	2304.4	2378.9	2454.3
50	2016.6	2087.7	2159.4	2232.1	2305.7	2380.1	2455.6
51	2017.8	2088.9	2160.7	2233.3	2306.9	2381.4	2456.9
52	2019.0	2090.1	2161.9	2234.6	2308.1	2382.6	2458.1
53	2020.2	2091.3	2163.1	2235.8	2309.4	2383.9	2459.4
54	2021.3	2092.5	2164.3	2237.0	2310.6	2385.1	2460.7
55	2022.5	2093.7	2165.5	2238.2	2311.8	2386.4	2461.9
56	2023.7	2094.9	2166.7	2239.4	2313.1	2387.6	2463.2
57	2024.9	2096.1	2167.9	2240.7	2314.3	2388.9	2464.5
58	2026.0	2097.3	2169.1	2241.9	2315.5	2390.2	2465.8
59	2027.2	2098.5	2070.3	2243.1	2316.7	2391.4	2467.0
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	31	32	33	34	35	36	37

L.	38	39	40	41	42	43	44
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	2468.3	2545.0	2622.7	2701.6	2781.7	2863.1	2945.7
1	2469.6	2546.2	2624.0	2702.9	2783.1	2864.5	2947.2
2	2470.8	2547.5	2625.3	2704.3	2784.4	2865.8	2948.6
3	2472.1	2548.8	2626.6	2705.6	2785.8	2867.2	2950.0
4	2473.4	2550.1	2627.9	2706.9	2787.1	2868.6	2951.4
5	2474.6	2551.4	2629.2	2708.3	2788.5	2870.0	2952.8
6	2475.9	2552.7	2630.5	2709.6	2789.8	2871.3	2954.2
7	2477.1	2554.0	2631.9	2710.9	2791.2	2872.7	2955.6
8	2478.5	2555.3	2633.2	2712.2	2792.5	2874.1	2957.0
9	2479.7	2556.6	2634.5	2713.6	2793.8	2875.4	2958.4
10	2481.0	2557.8	2635.8	2714.9	2795.1	2876.8	2959.8
11	2482.3	2559.1	2637.1	2716.2	2796.5	2878.2	2961.1
12	2483.5	2560.4	2638.4	2717.5	2797.9	2879.5	2962.5
13	2484.8	2561.7	2639.7	2718.9	2799.3	2880.9	2963.9
14	2486.1	2563.0	2641.0	2720.2	2800.6	2882.3	2965.3
15	2487.4	2564.3	2642.3	2721.5	2802.0	2883.7	2966.7
16	2488.6	2565.6	2643.6	2722.9	2803.3	2885.0	2968.1
17	2489.9	2566.9	2644.9	2724.2	2804.7	2886.4	2969.5
18	2491.2	2568.2	2646.3	2725.5	2806.0	2887.8	2970.9
19	9492.5	2569.5	2647.6	2726.9	2807.4	2889.2	2972.5
20	2493.7	2570.7	2648.9	2728.2	2808.7	2890.5	2973.7
21	2495.0	2572.0	2650.2	2729.5	2810.1	2891.9	2975.1
22	2496.3	2573.3	2651.5	2730.8	2811.4	2893.3	2976.5
23	2497.6	2574.6	2652.8	2732.2	2812.8	2894.7	2977.9
24	2498.8	2575.9	2654.1	2733.5	2814.1	2896.0	2979.3
25	3500.1	2577.2	2655.4	2734.8	2815.5	2897.4	2980.7
26	2501.4	2578.5	2656.8	2736.2	2816.8	2898.8	2982.1
27	2502.7	2579.8	2658.1	2737.5	2818.2	2900.2	2983.5
28	2503.9	2581.1	2659.4	2738.8	2819.5	2901.5	2984.9
29	2505.2	2582.4	2660.7	2740.2	2820.9	2902.9	2986.3
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	38	39	40	41	42	43	44

L.	38	39	40	41	42	43	44
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	2506.5	2583.7	2662.0	2741.5	2822.3	2904.3	2987.7
31	2507.8	2585.0	2663.3	2742.9	2823.6	2905.7	2989.1
32	2509.0	2586.3	2664.6	2744.2	2825.0	2907.1	2990.5
33	2510.3	2587.6	2666.0	2745.5	2826.3	2908.4	2991.9
34	2511.6	2588.9	2667.3	2746.9	2827.7	2909.7	2993.3
35	2512.9	2590.2	2668.6	2748.2	2829.0	2911.2	2994.7
36	2514.2	2591.5	2669.9	2749.5	2830.4	2912.6	2996.1
37	2515.4	2592.8	2671.2	2750.9	2831.8	2914.0	3997.5
38	2516.7	2594.1	2672.5	2752.2	2833.1	2915.3	2998.9
39	2518.0	2595.4	2673.9	2753.5	2834.5	2916.7	3000.3
40	2519.3	2596.7	2675.1	2754.9	2835.8	2918.1	3001.8
41	2520.6	2598.0	2676.5	2756.2	2837.2	2919.5	3003.2
42	2521.8	2599.3	2677.8	2757.6	2838.6	2920.9	3004.6
43	2523.1	2600.6	2679.1	2758.9	2839.9	2922.3	3006.0
44	2524.4	2601.9	2680.5	2760.2	2841.3	2923.6	3007.4
45	2525.7	2603.2	2681.8	2761.5	2842.6	2925.0	3008.8
46	2527.0	2604.5	2683.1	2762.9	2844.0	2926.4	3010.2
47	2528.3	2605.8	2684.4	2764.3	2845.4	2927.8	3011.6
48	2529.5	2607.1	2685.7	2765.6	2846.7	2929.2	3013.0
49	2530.8	2608.4	2687.1	2766.9	2848.1	2930.6	3014.4
50	2532.1	2609.7	2688.4	2768.3	2849.5	2932.0	3015.8
51	2533.4	2611.0	2689.7	2769.6	2850.8	2933.3	3017.2
52	2534.7	2612.3	2691.0	2771.0	2852.2	2934.7	3018.7
53	2536.0	2613.6	2692.3	2772.3	2853.6	2936.1	3020.1
54	2537.2	2614.9	2693.7	2773.7	2854.9	2937.5	3021.5
55	2538.5	2616.2	2695.0	2775.0	2856.3	2938.9	3022.9
56	2539.8	2617.5	2696.3	2776.4	2857.7	2940.3	3024.3
57	2541.1	2618.8	2697.6	2777.7	2859.1	2941.7	3025.7
58	2542.4	2620.1	2699.0	2779.0	2860.3	2943.1	3027.1
59	2543.7	2621.4	2700.3	2780.4	2861.8	2944.4	3028.5
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	38	39	40	41	42	43	44

L.	45	46	47	48	49	50	51
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	3030.0	3115.6	3202.8	3291.6	3382.1	3474.5	3568.8
1	3031.4	3117.0	3204.2	3293.1	3383.6	3476.1	3570.4
2	3032.8	3118.5	3205.7	3294.6	3385.2	3477.6	3572.0
3	3034.2	3119.9	3207.2	3296.1	3386.7	3479.2	3573.6
4	3035.6	3121.4	3208.6	3297.5	3388.2	3480.7	3575.2
5	3037.0	3122.8	3210.1	3299.0	3389.7	3482.3	3576.8
6	3038.4	3124.2	3211.6	3300.5	3391.3	3483.9	3578.4
7	3039.8	3125.7	3213.0	3302.0	3392.8	3485.4	3580.0
8	3041.3	3127.1	3214.5	3303.5	3394.3	3487.0	3581.6
9	3042.7	3128.6	3216.0	3305.0	3395.9	3488.5	3583.2
10	3044.1	3130.0	3217.4	3306.5	3397.4	3490.1	3584.8
11	3045.5	3131.5	3218.9	3308.0	3398.9	3491.7	3586.4
12	3047.0	3132.9	3220.4	3309.5	3400.4	3493.2	3588.0
13	3048.4	3134.3	3221.9	3311.0	3402.0	3494.8	3589.5
14	3049.8	3135.8	3223.3	3312.5	3403.5	3496.3	3591.1
15	3051.2	3137.2	3224.8	3314.0	3405.0	3497.9	3592.7
16	3052.6	3138.7	3226.3	3315.5	3406.6	3499.5	3594.3
17	3054.1	3140.1	3227.7	3317.0	3408.1	3501.0	3595.9
18	3055.5	3141.6	3229.2	3318.5	3409.6	3502.6	3597.5
19	3056.9	3143.0	3230.7	3320.0	3411.2	3504.2	3599.1
20	3058.3	3144.5	3232.2	3321.5	3412.7	3505.7	3600.7
21	3059.7	3145.9	3233.6	3323.1	3414.2	3507.3	3602.3
22	3061.2	3147.4	3235.1	3324.6	3415.8	3508.9	3603.9
23	3062.6	3148.8	3236.6	3326.1	3417.3	3510.5	3605.5
24	3064.0	3150.3	3238.1	3327.6	3418.8	3512.0	3607.1
25	3065.4	3151.7	3239.5	3329.1	3420.4	3513.6	3608.7
26	3066.9	3153.2	3241.0	3330.6	3421.9	3515.1	3610.3
27	3068.3	3154.6	3242.5	3332.1	3423.5	3516.7	3611.9
28	3069.7	3156.1	3244.0	3333.6	3425.0	3518.3	3613.6
29	3071.1	3157.5	3245.5	3335.1	3426.5	3519.8	3615.2
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	45	46	47	48	49	50	51

L.	45	46	47	48	49	50	51
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	3072.6	3159.0	3246.9	3336.6	3428.1	3521.4	3616.8
31	3074.0	3160.4	3248.4	3338.1	3429.6	3523.0	3618.4
32	3075.4	3161.9	3249.9	3339.6	3431.2	3524.6	3620.0
33	2076.9	3163.3	3251.4	3341.1	3432.7	3526.1	3621.6
34	3078.3	3164.8	3252.9	3342.7	3434.2	3527.7	3623.2
35	3079.7	3166.2	3254.4	3344.2	3435.8	3529.3	3624.8
36	3081.1	3167.7	3255.8	3345.7	3437.3	3530.9	3626.4
37	3082.5	3169.1	3257.3	3347.2	3438.9	3532.4	3628.0
38	3084.0	3170.6	3258.8	3348.7	3440.4	3534.0	3629.6
39	3085.4	3172.1	3260.3	3350.1	3442.0	3535.6	3631.3
40	3086.9	3173.5	3261.8	3351.7	3443.5	3537.2	3632.9
41	3088.3	3175.0	3263.3	3353.2	3445.0	3538.8	3634.5
42	3089.7	3176.4	3264.7	3354.8	3446.6	3540.3	3636.1
43	3091.2	3177.9	3266.2	3356.3	3448.1	3541.9	3637.7
44	3092.6	3179.3	3267.7	3357.8	3449.7	3543.5	3639.3
45	3094.0	3180.8	3269.2	3359.3	3451.2	3545.1	3640.9
46	3095.5	3182.3	3270.7	3360.8	3452.8	3546.7	3642.5
47	3096.9	3183.7	3272.2	3362.3	3454.3	3548.2	3644.2
48	3098.3	3185.2	3273.7	3363.9	3455.9	3549.8	3645.8
49	3099.8	3186.6	3275.2	3365.4	3457.4	3551.4	3647.4
50	3101.2	3188.1	3276.6	3366.9	3459.0	3553.0	3649.0
51	3102.6	3189.6	3278.1	3368.4	3460.5	3554.6	3650.6
52	3104.1	3191.0	3279.6	3369.9	3462.1	3556.2	3652.3
53	3105.6	3192.5	3281.1	3371.5	3463.6	3557.7	3653.9
54	3107.0	3194.0	3282.6	3373.0	3465.2	3559.3	3655.5
55	3108.4	3195.4	3284.1	3374.5	3466.7	3560.9	3957.1
56	3109.8	3196.9	3285.6	3376.0	3468.3	3562.5	3658.7
57	3111.2	3198.4	3287.1	4377.6	3469.8	3564.1	3660.4
58	3112.7	3199.8	3288.6	3379.1	3471.4	3565.7	3662.0
59	3114.1	3201.3	3290.1	3380.6	3473.0	3567.3	3663.6
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	45	46	47	48	49	50	51

L.	52	53	54	55	56	57	58
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	3665.2	3763.8	3864.7	3968.0	4073.9	4182.7	4294.3
1	3666.9	3765.5	3866.4	3969.7	4075.7	4184.5	4296.2
2	3668.5	3767.1	3868.1	3971.5	4077.5	4186.3	4298.1
3	3670.1	3768.8	3869.8	3973.2	4079.3	4188.2	4300.0
4	3671.7	3770.4	3871.5	3975.0	4081.1	4190.0	4301.9
5	3673.4	3772.1	3873.2	3976.7	4082.9	4191.8	4303.8
6	3675.0	3773.8	3874.9	3978.5	4084.7	4193.7	4305.7
7	3676.6	3775.4	3876.6	3980.2	4086.5	4195.5	4307.6
8	3678.2	3777.1	3878.3	3982.0	4088.3	4197.4	4309.5
9	3679.9	3778.8	3880.0	3983.7	4090.1	4199.2	4311.4
10	3681.5	3780.4	3881.7	3985.5	4091.9	4201.1	4313.2
11	3683.1	3782.1	3883.4	3987.2	4093.7	4202.9	4315.1
12	3684.8	3783.8	3885.1	3989.0	4095.5	4204.7	4317.0
13	3686.4	3785.5	3886.8	3990.7	4097.3	4206.6	4318.9
14	3688.0	3787.1	3888.6	3992.5	4099.1	4208.4	4320.8
15	3689.7	3788.8	3890.3	3994.2	4100.9	4210.3	4322.7
16	3691.3	3790.5	3892.0	3996.0	4102.7	4212.1	4324.6
17	3692.9	3792.1	3893.7	3997.7	4104.5	4214.0	4326.5
18	3694.6	3793.8	3895.4	3999.5	4106.3	4215.8	4328.4
19	3696.2	3795.5	3897.1	4001.3	4108.1	4217.7	4330.3
20	3697.8	3797.2	3898.8	4003.0	4109.9	4219.5	4332.2
21	3699.5	3798.8	3900.5	4004.8	4111.7	4221.4	4334.2
22	3601.1	3800.5	3902.3	4006.5	4113.5	4223.2	4336.1
23	3602.7	3802.2	3904.0	4008.3	4115.3	4225.1	4338.0
24	3704.4	3803.9	3905.7	4010.0	4117.1	4227.0	4339.9
25	3706.0	3805.5	3907.4	4011.8	4118.9	4228.8	4341.8
26	3707.7	3807.2	3909.1	4013.6	4120.7	4230.7	4343.7
27	3709.3	3808.9	3910.9	4015.3	4122.5	4232.5	4345.6
28	3710.9	3810.6	3912.6	4017.1	4124.3	4234.4	4347.5
29	3712.6	3812.3	3914.3	4018.9	4126.1	4236.2	4349.4
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	52	53	54	55	56	57	58

L.	52	53	54	55	56	57	58
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	3714.2	3813.9	3916.0	4020.6	4127.9	4238.1	4351.3
31	3715.9	3815.6	3917.7	4022.4	4129.7	4240.0	4353.3
32	3717.5	3817.3	3919.5	4024.2	4131.6	4241.8	4355.2
33	3719.2	3819.0	3921.2	4025.9	4133.4	4243.7	4357.1
34	3720.8	3820.7	3922.9	4027.7	4135.2	4245.6	4359.0
35	3722.4	3822.3	3924.6	4029.5	4137.0	4247.4	4360.9
36	3724.1	3824.0	3926.4	4031.2	4138.8	4249.3	4362.8
37	3725.7	3825.7	3928.1	4033.0	4140.6	4251.2	4364.8
38	3727.4	3827.4	3929.8	4034.8	4142.5	4253.0	4366.7
39	3729.0	3829.1	3931.5	4036.6	4144.3	4254.9	4368.6
40	3730.7	3830.8	3933.3	4038.3	4146.1	4256.8	4370.5
41	3732.3	3832.5	3935.0	4040.1	4147.9	4258.6	4372.5
42	3734.0	3834.2	3936.7	4041.9	4149.7	4260.5	4374.4
43	3735.6	3835.8	3938.5	4043.6	4151.6	4262.4	4376.3
44	3737.3	3837.5	3940.2	4045.4	4153.4	4264.3	4378.2
45	3738.9	3839.2	3941.9	4047.2	4155.2	4266.1	4380.2
46	3740.6	3840.9	3943.7	4049.0	4157.0	4268.0	4382.1
47	3742.2	3842.6	3945.4	4050.8	4158.8	3269.9	4384.0
48	3743.9	3844.3	3947.1	4052.5	4160.7	4271.8	4385.9
49	3745.6	3846.0	3948.9	4054.3	4162.5	4273.6	4387.9
50	3747.2	3847.7	3950.6	4056.1	4164.3	4275.5	4389.8
51	3748.9	3849.4	3952.3	4057.9	4166.2	4277.4	4391.7
52	3750.5	3851.1	3954.1	4059.7	4168.0	4279.3	4393.7
53	3752.2	3852.8	3955.8	4061.4	4169.8	4281.1	4395.6
54	3753.8	3854.5	3957.6	4063.2	4171.7	4283.0	4397.5
55	3755.5	3856.2	3959.3	4065.0	4173.5	4284.9	4399.5
56	3757.2	3857.9	3961.0	4066.8	4175.3	4286.8	4401.4
57	3758.8	3859.6	3962.8	4068.6	4177.2	4288.7	4403.4
58	3760.5	3861.3	3964.5	4070.4	4179.0	4290.6	4405.3
59	3762.2	3863.9	3966.3	4072.2	4180.8	4292.5	4407.2
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	52	53	54	55	56	57	58

L.	59	60	61	62	63	64	65
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	4409.2	4527.4	4649.3	4775.0	4905.0	5039.5	5178.8
1	4411.1	4529.4	4651.3	4777.1	4907.2	5041.7	5181.2
2	4413.1	4531.4	4653.4	4779.3	4909.4	5044.0	5183.6
3	4415.0	4533.4	4655.5	4781.4	4911.6	5046.3	5186.0
4	4417.0	4535.4	4657.5	4783.5	4013.8	5048.6	5188.3
5	4418.9	4537.4	4659.6	4785.7	4916.0	5050.9	5190.7
6	4420.8	4539.4	4661.7	4787.8	4918.2	5053.2	5193.1
7	4422.8	4541.4	4663.7	4790.0	4920.4	5055.5	5195.4
8	4424.7	4543.4	4665.8	4792.1	4922.6	5057.7	5197.8
9	4426.7	4545.4	4667.9	4794.2	4924.8	5060.0	5200.2
10	4428.6	4547.5	4669.9	4796.4	4927.1	5062.3	5202.6
11	4430.6	4549.5	4672.0	4798.5	4929.3	5064.6	5205.0
12	4432.5	4551.5	4674.1	4800.7	4931.5	5066.9	5207.3
13	4434.5	4553.5	4676.2	4802.8	4933.7	5069.2	5209.7
14	4436.4	4555.5	4678.2	4804.9	4935.9	5071.5	5212.1
15	4438.4	4557.5	4680.3	4807.1	4938.1	5073.8	5214.5
16	4440.4	4559.5	4682.4	4809.2	4940.4	5076.1	5216.9
17	4442.3	4561.5	4684.5	4811.4	4942.6	5078.4	5219.3
18	4444.3	4563.6	4686.6	4813.5	4944.8	5080.7	5221.7
19	4446.2	4565.9	4688.6	4815.7	4947.0	5083.0	5224.1
20	4448.2	4567.6	4690.7	4817.8	4949.3	5085.3	5226.5
21	4450.2	4569.6	4692.8	4820.0	4951.5	5087.7	5228.9
22	4452.1	4571.6	4694.9	4822.2	4953.7	5090.0	5231.3
23	4454.1	4573.7	4697.0	4824.3	4956.0	5092.3	5233.7
24	4456.0	4575.7	4699.1	4826.5	4958.2	5094.6	5236.1
25	4458.0	4577.7	4701.2	4828.6	4960.4	5096.9	5238.5
26	4460.0	4579.7	4703.2	4830.8	4962.7	5099.2	5240.0
27	4461.9	4581.8	4705.3	4832.9	4964.9	5101.5	5243.3
28	4463.9	4583.8	4707.4	4835.1	4967.1	5103.9	5245.7
29	4469.5	4585.8	4709.5	4837.3	4969.4	5106.2	5248.1
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	59	60	61	62	63	64	65

L.	59	60	61	62	63	64	65
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	4467.8	4587.8	4711.6	4839.4	4971.6	5108.5	5250.5
31	4469.8	4589.9	4713.7	4841.6	4973.9	5110.8	5252.9
32	4471.8	4591.9	4715.8	4843.8	4976.1	5113.1	5255.3
33	4473.8	4593.9	4717.9	4845.9	4978.3	5115.5	5257.7
34	4475.8	4596.0	4720.0	4848.1	4980.6	5117.8	5260.1
35	4477.7	4598.0	4722.6	4850.3	4982.8	5120.1	5262.6
36	4479.7	4600.1	4724.2	4852.5	4985.1	5122.5	5265.0
37	4481.7	4602.1	4726.3	4854.6	4987.3	5124.8	5267.4
38	4483.6	4604.1	4728.4	4856.8	4989.6	5127.1	5269.8
39	4485.6	4606.2	4730.5	4859.0	4991.8	5129.5	5272.3
40	4488.6	4608.2	4732.6	4861.2	4994.1	5131.8	5274.7
41	4489.6	4610.3	4734.7	4863.3	4996.3	5134.1	5277.1
42	4491.6	4612.3	4736.9	4865.5	4998.6	5136.5	5279.5
43	4493.5	4614.3	4739.0	4867.7	5000.9	5138.8	5282.9
44	4495.5	4616.4	4741.4	4869.9	5003.1	5141.2	5284.4
45	4497.5	4618.4	4743.2	4872.1	5055.4	5143.5	5286.8
46	4499.5	4620.5	4745.3	4874.3	5007.6	5145.9	5289.3
47	4501.5	4622.5	4747.4	4876.4	5009.9	5148.2	5291.7
48	4503.5	4624.6	4749.5	4878.6	5012.2	5150.6	5294.2
49	4505.5	4626.6	4751.7	4880.8	5014.4	5152.9	5296.6
50	4507.5	4628.7	4753.8	4882.0	5016.7	5155.3	5299.0
51	4509.4	4630.7	4755.9	4885.2	5019.0	5157.6	5301.5
52	4511.4	4632.8	4758.0	4887.4	5021.2	5160.0	5303.9
53	4513.4	4634.8	4760.1	4889.6	5023.5	5162.3	5306.4
54	4515.4	4636.9	4762.3	4891.1	5025.8	5164.7	5308.8
55	4517.4	4639.0	4764.4	4894.0	5028.1	5167.0	5311.3
56	4519.4	4641.0	4766.5	4896.2	5030.3	5169.4	5313.7
57	4521.4	4643.1	4768.6	4898.4	5032.6	5171.8	5316.2
58	4523.4	4645.1	4770.8	4900.6	5034.9	5174.1	5318.6
59	4525.4	4647.2	4772.9	4902.8	5037.2	5176.5	5321.1
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	59	60	61	62	63	64	65

L.	66	67	68	69	70	71	72
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
0	5323.6	5474.0	5630.9	5794.6	5966.0	6145.7	6334.9
1	5326.0	5476.6	5633.5	5797.4	5968.9	6148.8	6338.1
2	5328.5	5479.2	5636.2	5800.2	5971.8	6151.9	6341.4
3	5330.9	5481.7	5638.9	5803.0	5974.7	6155.0	6344.6
4	5333.4	5484.3	5641.5	5805.8	5977.7	6158.0	6347.8
5	5335.9	5486.9	5644.2	5808.6	5980.6	6161.1	6351.1
6	5338.3	5489.4	5646.9	5811.4	5983.5	6164.2	6354.3
7	5340.8	5492.0	5649.0	5814.2	5986.5	6167.3	6557.6
8	5343.3	5494.6	5652.3	5817.0	5989.4	6170.4	6360.9
9	5345.7	5497.1	5655.0	5819.8	5992.4	6173.5	6364.1
10	5348.2	5499.7	5657.6	5822.6	5995.3	6176.6	6367.4
11	5350.7	5502.3	5660.3	5825.4	5998.3	6179.7	6370.6
12	5353.2	5504.9	5663.0	5828.2	6001.2	6182.8	6373.9
13	5355.6	5507.5	5665.7	5831.0	6004.2	6185.9	6377.2
14	5358.1	5510.0	5668.4	5833.9	6007.1	6189.0	6380.5
15	5360.6	5512.6	5671.1	5836.7	6010.1	6192.1	6383.7
16	5363.1	5515.2	5673.8	5839.5	6013.0	6195.2	6387.0
17	5365.6	5517.8	5679.5	5842.3	6016.0	6198.3	6390.3
18	5368.1	5520.4	5679.2	5845.2	6019.0	6201.4	6393.6
19	5370.5	5523.0	5681.9	5848.0	6021.9	6204.6	6396.9
20	5373.0	5525.6	5684.6	5850.8	6024.9	6207.7	6400.2
21	5375.5	5528.2	5687.3	5853.7	6027.9	6210.8	6403.5
22	5378.0	5530.8	5690.0	5856.5	6030.8	6213.9	6406.8
23	5380.5	5533.4	5692.8	5859.3	6033.8	6217.1	6410.1
24	5383.0	5536.0	5695.5	5862.2	6036.8	6220.2	6413.4
25	5385.5	5538.6	5698.2	5865.0	6039.8	6223.3	6416.7
26	5388.0	5541.2	5700.9	5867.9	6042.7	6226.5	6420.0
27	5390.5	5543.7	5703.6	5870.7	6045.7	6229.6	6423.3
28	5393.0	5546.4	5706.3	5873.5	6048.7	6232.7	6426.6
29	5395.5	5549.0	5709.1	5876.4	6051.7	6235.9	6429.9
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L	66	67	68	69	70	71	72

L.	66	67	68	69	70	71	72
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	5398.0	5551.6	5711.8	5879.3	6054.7	6239.0	6433.2
31	5400.5	5554.2	5714.5	5882.1	6057.7	6242.2	6436.6
32	5403.0	5556.8	5717.3	5885.0	6060.7	6245.3	6439.9
33	5405.6	5559.5	5720.0	5887.8	6063.7	6248.5	6443.3
34	5408.1	5562.1	5722.7	5890.7	6066.7	6251.7	6446.6
35	5410.6	5564.7	5725.5	5893.6	6069.7	6254.8	6449.9
36	5413.1	5567.3	5728.2	5896.4	6062.7	6258.0	6453.3
37	5415.6	5569.9	5731.0	5899.3	6075.7	6261.2	6456.6
38	5418.1	5572.6	5733.7	5902.2	6078.8	6264.4	6460.0
39	5420.7	5575.2	5736.4	5905.1	6081.8	6267.5	6463.3
40	5423.2	5577.8	5739.2	5907.9	6084.8	6270.7	6466.7
41	5425.7	5580.5	5741.9	5910.8	6087.8	6273.9	6470.0
42	5428.2	5583.1	5744.7	5913.7	6090.8	6277.1	6473.4
43	5430.8	5585.7	5747.5	5916.6	6093.9	6280.3	6476.8
44	5433.3	5588.4	5750.2	5919.5	6096.9	6283.5	6480.1
45	5435.8	5591.0	5753.0	5922.4	6099.9	6286.6	6483.5
46	5438.4	5593.7	5755.7	5925.2	6103.0	6289.8	6486.9
47	5440.9	5596.3	5758.5	5928.1	6106.0	6293.0	6490.3
48	5443.5	5599.0	5761.3	5931.0	6109.1	6296.2	6493.6
49	5446.0	5601.6	5764.0	5933.9	6112.1	6299.4	6497.0
50	5449.5	5604.3	5766.8	5936.8	6115.1	6302.7	6500.4
51	5451.1	5606.9	5769.6	5939.7	6118.2	6305.9	6503.8
52	5453.6	5609.6	5772.3	5942.6	6121.2	6309.1	6507.2
53	5456.2	5612.2	5775.1	5945.5	6124.3	6312.3	6510.6
54	5458.7	5614.9	5775.9	5948.5	6127.4	6315.5	6514.0
55	5461.3	5617.5	5780.7	5951.4	6130.4	6318.7	6517.4
56	5463.8	5620.2	5783.5	5954.3	6133.5	6322.0	6520.8
57	5466.4	5622.9	5786.2	5957.2	6136.5	6325.2	6524.2
58	5468.9	5625.5	5789.0	5960.1	6139.6	6328.4	6527.6
59	5471.5	5628.2	5791.8	5963.0	6142.7	6331.7	6531.0
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	66	67	68	69	70	71	72

L.	73	74	75	76	77	78	79
M	Min.	Min	Min.	Min.	Min.	Mip.	Min.
0	6534.5	6745.7	6970.3	7210.1	7467.2	7744.6	8045.7
1	6537.9	6749.4	6974.2	7214.2	7471.7	7749.4	8051.0
2	6541.3	6753.0	6978.1	7218.3	7476.1	7754.2	8056.2
3	6544.7	6756.6	6981.9	7222.5	7480.6	7759.0	8061.5
4	6548.2	6760.3	6985.8	7226.6	7485.0	7763.9	8066.8
5	6551.6	6763.9	6989.9	7230.8	7489.5	7768.7	8072.0
6	6555.0	6767.6	6993.6	7234.9	7494.0	7773.5	8077.3
7	6558.5	6771.2	6997.5	7239.1	7498.5	7778.4	8082.6
8	6561.9	6774.9	7001.4	7243.3	7502.9	7783.2	8087.9
9	6565.4	6780.5	7005.3	7247.5	7507.5	7788.1	8093.2
10	6568.8	6782.2	7009.2	7251.6	7511.9	7793.0	8098.5
11	6572.3	6785.8	7013.1	7255.8	7516.4	7797.8	8103.8
12	6575.7	6789.5	7017.0	7260.0	7520.9	7802.7	8109.2
13	6579.2	6793.2	7020.9	7264.2	7525.4	7807.6	8114.5
14	6582.6	6796.9	7024.8	7268.4	7530.0	7812.5	8119.8
15	6586.1	6800.5	7028.7	7272.6	7534.5	7817.4	8125.2
16	6589.5	6804.2	7032.7	7276.8	7539.0	7822.3	8130.6
17	6593.0	6807.9	7036.6	7281.0	7543.6	7827.2	8135.9
18	6596.5	6811.6	7040.5	7285.2	7548.1	7832.2	8141.3
19	6600.0	6815.3	7044.5	7289.4	7552.7	7837.1	8146.7
20	6603.4	6819.0	7048.7	7293.7	7557.2	7842.0	8152.1
21	6606.9	6822.7	7052.7	7297.9	7561.8	7847.0	8157.5
22	6610.4	6826.4	7056.6	7302.1	7566.3	7851.9	8162.9
23	6613.9	6830.1	7060.5	7306.4	7570.9	7856.9	8168 3
24	6617.4	6833.8	7064.5	7310.6	7575.5	7861.9	8173.7
25	6620.9	6837.6	7068.2	7314.9	7580.1	7866.8	8179.2
26	6624.4	6841.3	7072.2	7319.1	7584.7	7871.8	8184.6
27	6627.9	6845.0	7076.2	7323.4	7589.3	7876.8	8190.1
28	6631.4	6848.7	7080.1	7327.7	7593.9	7881.8	8195.5
29	6635.0	6852.5	7084.1	7332.0	3598.3	7886.8	8201.0
M	Min.	Min.	Min.	Min.	Min.	Min.	Min.
L.	73	74	75	76	77	78	79

L.	73	74	75	76	77	78	79
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	6638.5	6856.2	7088.1	7336.2	7603.1	7891.8	8206.5
31	6642.0	6860.0	7092.1	7340.5	7607.7	7896.8	8212.0
32	6645.5	6863.7	7096.1	7344.8	7612.3	7901.9	8217.5
33	6649.1	6867.5	7100.1	7349.1	7617.0	7906.9	8223.0
34	6652.6	6871.2	7104.1	7353.4	7621.6	7911.9	8228.5
35	6656.1	6875.0	7108.2	7357.7	7626.3	7917.0	8234.1
36	6659.7	6878.7	7112.2	7362.0	7630.9	7922.1	8239.6
37	6663.2	6882.5	7116.2	7366.4	7635.6	7927.1	8245.1
38	6666.8	6886.3	7120.2	7370.7	7640.2	7932.2	8250.7
39	6670.3	6890.1	7124.3	7375.0	7644.9	7937.3	8256.3
40	6673.9	6893.8	7128.3	7379.4	7649.6	7942.4	8261.8
41	6677.5	6897.6	7132.3	7383.7	7654.3	7947.5	8267.4
42	6681.0	6901.4	7136.4	7388.0	7659.0	7952.6	8273.0
43	6684.6	6905.2	7140.4	7392.4	7663.7	7957.7	8278.6
44	6688.1	6909.0	7144.5	7396.8	7668.4	7962.8	8284.2
45	6991.7	6912.8	7148.6	7401.1	7673.1	7968.0	8[illegible]89.9
46	6695.3	6916.6	7152.6	7405.5	7677.8	7973.1	8295.5
47	6698.9	6920.4	7156.7	7409.9	7682.6	7978.2	8301.1
48	6702.4	6924.3	7160.8	7414.2	7687.3	7983.4	8306.8
49	6706.0	6928.1	7164.9	7418.6	7692.0	7988.5	8312.4
50	6709.6	6931.9	7169.0	7423.0	7696.8	7993.7	8318.1
51	6713.2	6935.7	7173.0	7427.4	7701.5	7998.9	8323.8
52	6716.8	6939.5	7177.1	7431.8	7706.3	8004.0	8329.4
53	6720.4	6943.4	7181.2	7436.2	7711.0	8009.2	8335.1
54	6724.0	6947.2	7185.3	7440.6	7715.8	8014.4	8340.8
55	6727.6	6951.1	7189.5	7445.0	7720.6	8019.6	8346.6
56	6731.2	6954.9	7193.6	7449.5	7725.4	8024.8	8352.3
57	6734.9	6958.8	7197.7	7453.9	7730.2	8030.0	8358.0
58	6738.5	6962.6	7201.8	7458.3	7735.0	8035.3	8363.7
59	6742.1	6966.5	7205.9	7462.8	7739.8	8040.5	8369.5
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	73	74	75	76	77	78	79

L.	80	81	82	83	84
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	8375.3	8739.1	9145.6	9605.9	10137.0
1	8381.0	8745.5	9152.7	9614.1	10146.6
2	8386.8	8751.9	9159.9	9622.4	10156.2
3	8392.6	8758.3	9167.2	9630.6	10165.8
4	8398.3	8764.8	9174.4	9638.9	10175.4
5	8404.1	8771.2	9181.5	9647.2	10185.1
6	8409.9	8777.7	9188.9	9655.2	10194.8
7	8415.8	8784.1	9196.2	9663.8	10204.6
8	8421.6	8790.6	9203.5	9672.2	10214.4
9	8427.4	8797.1	9210.8	9680.6	10224.2
10	8433.3	8803.6	9218.1	9689.0	10234.0
11	8439.1	8810.1	9225.4	9697.4	10243.8
12	8445.0	8816.6	9232.8	9705.8	10253.7
13	8450.9	8823.2	9240.2	9714.2	10263.6
14	8456.8	8829.7	9247.6	9722.7	10273.5
15	8462.6	8836.3	9255.0	9731.2	10283.5
16	8468.6	8842.8	9262.4	9739.7	10293.5
17	8474.5	8849.4	9269.9	9748.3	10303.5
18	8480.4	8856.0	9277.3	9756.8	10313.6
19	8486.3	8862.6	9284.8	9765.4	10323.7
20	8492.3	8869.3	9292.3	9774.0	10333.8
21	8498.2	8875.9	9299.8	9782.7	10344.0
22	8504.2	8882.6	9307.3	9791.3	10354.1
23	8510.2	8889.2	9314.8	9800.0	10364.3
24	8516.2	889.95	9322.4	9808.6	10374.5
25	8522.2	8902.6	9330.0	9817.3	10384.8
26	8528.2	8909.3	9337.5	9826.1	10395.1
27	8534.2	8916.0	9345.2	9834.8	10405.4
28	8540.2	8922.7	9352.8	9843.6	10415.8
29	8546.2	8929.5	9360.4	9852.4	10426.2
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	80	81	82	83	84

L.	80	81	82	83	84
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	8552.3	8936.2	9368.1	9861.3	10436.6
31	8558.4	8943.0	9375.8	9870.1	10447.1
32	8564.4	8949.8	9383.5	9879.0	10457.5
33	8570.5	8956.6	9391.2	9887.8	10468.0
34	8576.6	8963.4	9398.9	9896.7	10478.5
35	8582.7	8970.2	9406.6	9905.7	10489.1
36	8588.9	8977.1	9414.4	9914.6	10499.7
37	8595.0	8983.9	9422.1	9923.5	10510.4
38	8601.1	8990.8	9429.9	9932.7	10521.1
39	8607.3	8997.7	9437.8	9941.7	10531.8
40	8613.5	9004.6	9445.6	9950.8	10542.6
41	8619.6	9011.5	9453.4	9959.8	10553.3
42	8625.8	9018.4	9461.3	9968.9	10564.1
43	8632.0	9025.4	9469.1	9978.0	10574.9
44	8638.2	9032.3	9477.0	9987.2	10585.8
45	8644.5	9039.3	9484.9	9996.3	10596.7
46	8650.7	9046.3	9492.9	10005.5	10607.7
47	8656.9	9053.3	9500.8	10014.8	10618.7
48	8663.2	9060.3	9508.8	10024.0	10629.7
49	8669.5	9067.3	9516.8	10033.3	10640.8
50	8675.7	9074.4	9524.8	10042.6	10651.9
51	8682.0	9081.4	9532.9	10051.9	10663.0
52	8688.3	9088.5	9540.9	10061.3	10674.1
53	8694.1	9095.6	9548.9	10070.6	10685.3
54	8701.0	9102.6	9557.0	10080.0	10696.5
55	8707.3	9109.8	9565.1	10089.4	10707.7
56	8713.6	9116.9	9573.2	10098.9	10719.1
57	8720.0	9124.0	9581.4	10108.4	10730.4
58	8726.4	9131.2	9589.5	10117.9	10741.8
59	8732.7	9138.4	9597.7	10127.4	10753.3
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	80	81	82	83	84

L.	85	86	87	88	89
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	10764.7	11532.6	12522.3	13916.6	16299.8
1	10776.2	11547.0	12541.4	13945.4	16357.5
2	10787.7	11561.4	12560.7	13974.4	16416.3
3	10799.3	11575.9	12580.0	14003.7	16476.1
4	10811.0	11590.5	12599.5	14033.2	16535.0
5	10822.5	11605.0	12619.1	14063.0	16594.9
6	10834.2	11619.8	12638.9	14093.0	16662.0
7	10845.9	11634.5	12658.6	14123.3	16726.2
8	10857.7	11649.3	12678.6	14153.9	16791.7
9	10869.6	11664.1	12698.6	14184.7	16858.5
10	10881.4	11679.1	12718.8	14215.8	16926.5
11	10893.3	11694.0	12739.1	14247.2	16990.6
12	10905.2	11709.1	12759.5	14278.9	17066 9
13	10917.2	11724.2	12780.0	14310.9	17130.3
14	10929.1	11739.4	12800.7	14343.2	17213.2
15	10941.2	11754.7	12821.5	14375.8	17288.7
16	10953.3	11770.0	12842.5	14408.7	17366.0
17	10965.5	11785.4	12863.5	14441.9	17445.0
18	10977.7	11800.9	12884.7	14475.4	17525.9
19	10989.9	11816.4	12906.0	14509.3	17608.7
20	11002.2	11832.0	12927.4	14543.5	17693.6
21	11014.5	11847.6	12948.9	14578.1	17780.7
22	11026.9	11863.4	12970.6	14613.9	17869.9
23	11039.3	11879.2	12992.5	14648.3	17961.6
24	11051.7	11895.1	13014.4	14683.9	18055.8
25	11064.2	11911.0	13036.6	14719.9	18152.6
26	11076.8	11927.1	13058.8	14756.3	18252.3
27	11089.3	11943.1	13081.2	14793.0	18354.9
28	11102.0	11959.4	13103.8	14830.2	18460.7
29	11114.6	11975.6	13126.5	14867.8	18569.8
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	85	86	87	88	89

L.	85	86	87	88	89
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
30	11127.4	11992.0	13149.3	14905.8	18682.5
31	11140.1	12008.4	13172.3	14944.2	18799.1
32	11152.9	12024.9	13195.5	14983.0	18919.7
33	11165.8	12041.5	13218.8	15022.3	19044.7
34	11178.7	12058.2	13242.3	15062.1	19174.4
35	11191.7	12074.9	13265.9	15102.3	19309.2
36	11204.7	12091.7	13289.7	15143.0	19449.5
37	11217.7	12108.6	13313.7	15184.2	19595.8
38	11230.9	12125.6	13337.8	15225.8	19748.6
39	11244.0	12142.7	13362.1	15268.0	19908.5
40	11257.2	12159.9	13386.6	15310.7	20075.2
41	11270.5	12177.1	13411.2	15354.0	20252.5
42	11283.8	12194.4	13436.1	15397.8	20438.3
43	11297.1	12211.8	13461.1	15442.1	20634.8
44	11310.6	12229.3	13486.3	15487.0	20843.1
45	11324.0	12246.9	13511.6	15532.6	21064.9
46	11337.6	12264.6	13537.2	15578.7	21302.0
47	11351.1	12282.4	13563.0	15625.5	21556.6
48	11364.8	12300.2	13588.9	15673.0	21831.7
49	11378.4	12318.2	13615.1	15721.0	22130.6
50	11392.2	12336.3	13641.4	15769.8	22458.0
51	11406.0	12354.4	13668.0	15819.3	22819.9
52	11419.8	12372.7	13694.7	15869.5	23224.3
53	11433.7	12391.0	13721.7	15920.4	23682.9
54	11447.7	12409.5	13748.9	15972.1	24211.8
55	11461.7	12428.0	13776.3	16024.6	24836.9
56	11475.8	12446.7	13803.9	16077.9	25600.8
57	11489.9	12465.3	13831.7	16132.0	26582.9
58	11504.1	12484.2	13859.8	16187.0	27958.0
59	11518.3	12503.1	13888.1	16242.9	36364.3
M	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
L.	85	86	87	88	89

SECT. XI.

Of Oblique Sailing.

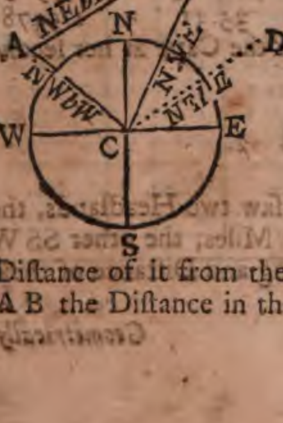
THE Queſtions that may be propoſed on this Head being innumerable, I ſhall only give a few of the moſt uſeful.

PROB. 1.

Coaſting along the Shore, I ſaw a Cape bear from me N N E, then I ſtood away N W *b* W 20 Miles, and I obſerved the ſame Cape to bear from me NE*b*E; required the Diſtance of the Ship from the Cape at each Station.

Geometrically.

Draw the Circle N W S E to repreſent the Compaſs, N S the Meridian, and W E the Eaſt and Weſt Line, and let C be the Place of the Ship in her firſt Station; then from C ſet off upon the N W *b* W Line, C A 20 Miles, and A will be the Place of the Ship in her ſecond Station.



From C draw the N N E Line C B, and from A draw A B parallel to the N E *b* E Line C D, which will meet C B in B, the Place of the Cape, and C B will be the Diſtance of it from the Ship in it's firſt Station, and A B the Diſtance in the Second. To find which

By Calculation.

In the Triangle A C B are given A C, equal to 20 Miles, the Angle A C B equal to 78°, 45′, the Diſtance between the N N E and N W *b* W Lines, alſo the Angle A B C, equal to B C D (by *Art.* 36. *Sect.* I.) equal to 33°, 45′, the Diſtance between the NNE and NE*b*E Lines; and conſequently the Angle A equal to 67°, 30′ (by *Cor.* 1. *Art.* 61. *Sect.* I.)

Hence for C B, the Diſtance of the Cape from the Ship in her firſt Station, it will be (by *Caſe* 2. of *Oblique Trigonometry*)

S. A B C : A C : : S. B A C : C B.

i. e. As the Sine of the Angle B	33°, 45′	9.74474
is to the Diſtance run A C - -	20 -	1.30103
ſo is the Sine of B A C - -	67°, 30′	9.96562
to C B - - - - - - -	33.26 -	1.52191

the Diſtance of the Cape from the Ship at the firſt Station. Then for A B it will be (*by the ſame Caſe*)

S. A B C : A C : : S. A C B : A B.

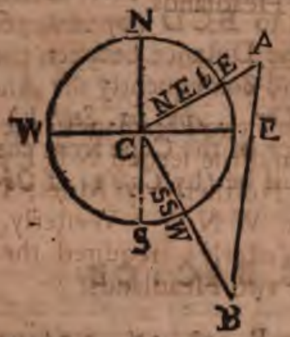
i. e. As the Sine of B - -	33°, 45′ -	9.74474
is to A C - - - - - -	20 - -	1.30103
ſo is the Sine of C - - -	78°, 45′ -	9.99157
to A B - - - - - -	35.31 -	1.54786

the Diſtance of the Ship from the Cape at her ſecond Station.

PROB. 2.

Coaſting along the Shore I ſaw two Headlands, the firſt bore from me NE*b*E 17 Miles, the other SSW 20 Miles; required the Bearing and Diſtance of theſe Headlands from one another.

Geometrically.



Having drawn the Compaſs N W S E, let C repreſent the Place of the Ship, ſet off upon the N E *b* E Line C A 17 Miles from C to A, and upon the S S W Line C B 20 Miles from C to B, and join A B, then A will be the firſt Headland, and B the ſecond; alſo A B will be their Diſtance, and the Angle A will be the Bearing from the N E *b* E Line, to find which

By Calculation.

In the Triangle A C B are given, A C 17, C B 20, and the Angle A C B equal to 101°, 15′, the Diſtance between the N E *b* E and S S W Lines. Hence by *Caſe* 4. *of Oblique Angular Trigonometry* it will be

As the Sum of the Sides A C and C B 37 1.56820
is to their Difference - - - - - 3 0.47712
ſo is the Tang. of $\frac{1}{2}$ the Sum of the Angles A and B } 39°, 22$\frac{1}{2}$′ 9.91417
to the Tang. of Half their Diff. 3°, 49′ - 8.82309

conſequently the Angle A will be 43°, 11′, and the Angle B 35°, 34′; alſo the Bearing of B from A will be S *b* W 1°, 49′, Weſterly, and the Bearing of A from B will be N *b* E 1°, 49′, Eaſterly.

Then for the Diſtance A B it will be, by *Caſe* 2. *Oblique Angular Trigonometry,*

S. A : CB :: S. C : AB.

i. e. As the Sine of A	43°, 11′	9.83527
is to CB	20	1.30103
ſo is the Sine of C	101°, 15′	9.99157
to AB	28.67	1.45733

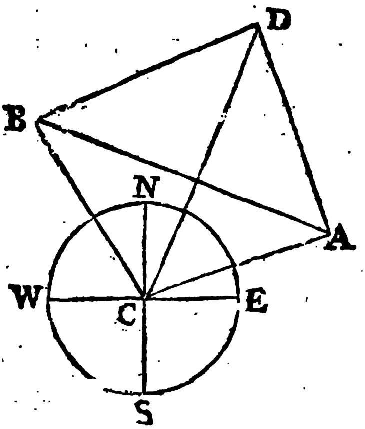
the Diſtance between the two Headlands.

PROB. 3.

Coaſting along the Shore I ſaw two Headlands, the firſt bore from the N W *b* N, and the ſecond N N E; then ſtanding away E *b* N $\frac{3}{4}$ Northerly 20 Miles, I found the firſt bore from me W N W $\frac{1}{2}$ Weſterly, and the ſecond N *b* W $\frac{1}{2}$ Weſterly; required the Bearing and Diſtance of theſe two Headlands.

Geometrically.

Having drawn the Compaſs NWSE, let C repreſent the firſt Place of the Ship, from which draw the



NW*b*N Line CB, and the NNE Line CD, alſo the E*b*N $\frac{3}{4}$ N Line CA, which make equal to 20.

From A draw A B parallel to the W N W½W Line, and A D parallel to the N *b* W½W meeting the two firſt Lines in the Points B and D; then B will be the firſt, and D the ſecond Headland. Join the Points B and D, and B D will be the Diſtance between them, and the Angle C D B the Bearing from the N N E Line. To find which

By Calculation.

1. In the Triangle A B C are given the Angle B C A, equal to 104°, 04′, the Diſtance between the N W*b*N Line, and the E N E¼E Line, the Ang. B A C equal to 36°, 34′, the Diſtance between the W S W¼W Line and the W N W½W Line, the Angle A B C equal to 39°, 22′, the Diſtance between the E S E½E Line, and the S W *b* S Line, alſo the Side C A equal to 20 Miles, whence for C B it will be, by *Caſe* 2. *of Plane Trigonometry*,

As the Sine of C B A - -	39°, 22′ -	9.80228
is to A C - - - - - - -	20 - -	1.30103
ſo is the Sine of B A C -	36°, 34′ -	9.77507
to C B - - - - - - -	18.79 -	1.27382

the Diſtance between the firſt Headland and the Ship in her firſt Station.

2. In the Triangle A C D, are given the Angle A C D equal to 47°, 49′, the Diſtance between the E N E¼E Line, and the N N E Line, the Angle C A D equal to 92°, 42′, the Diſtance between the W S W½W Line, and the N *b* W½W Line, the Angle C D A equal to 39°, 22′, the Diſtance between the S S W Line, and the S *b* E½E Line, alſo the Leg C A equal to 20.

Hence for C D it will be, by *Caſe* 2. *of Oblique Trigonometry*,

As

As the Sine C A D - -	39°, 22′ -	9.80228
is to A C - - - - - - -	20 -	1.30103
ſo is the Sine of C A D -	92°, 34′ -	9.99960
to C D - - - - - - -	31.5 -	1.49835

the Diſtance between the ſecond Headland and the Ship in her firſt Station.

3. In the Triangle B C D are given B C 18.79, C D 31.5, and the Angle B C D equal to 56°, 15′, the Diſtance between the N W *b* N Line, and the N N E Line.

Hence for the Angle C D B it will be (by *Caſe* 4. *of Oblique Trigonometry*)

As the Sum of the Sides -	50.29 -	1.70148
is to the Difference of Sides	12.71 -	1.10415
ſo is Tangent of ½ Sum of the unknown Angles	61°, 52′ -	10.27189
to Tang. of Half their Diff.	25°, 18′ -	9.67456

conſequently the Angle C B D is 87°, 10′, and the Angle C D B 36°, 35′. Hence the Bearing of the firſt Headland from the ſecond will be S 59°, 8′, W or S W *b* W ½ W nearly, and for the Diſtance between them it will be,

As the Sine of B D C -	36°, 35′ -	9.77524
is to B C - - - - - - -	18.79 -	1.27382
ſo is the Sine of B C D -	56°, 15′ -	9.91985
to B D - - - - - - -	26.21 -	1.41843

the Diſtance between the two Headlands.

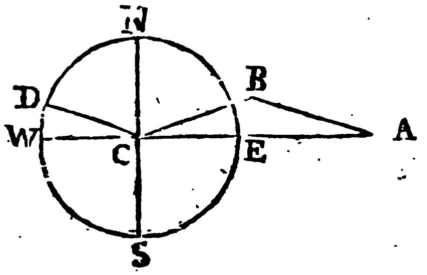
This and the firſt Problem, are of great Uſe in drawing the Plot of any Harbour, or laying down any Sea-Coaſt.

PROB. 4.

Suppoſe a Ship that makes her Way good within 6 ½ Points of the Wind, at North, is bound to a Port bearing Eaſt 86 Miles Diſtance from her; required the Courſe and Diſtance upon each Tack, to gain the intended Port.

Geometrically.

Having drawn the Compaſs NESW, let C repreſent the Ship's Place, and ſet off upon the Eaſt Line CA 86 Miles, ſo A will be the intended Port. Draw CD and CB on each Side of the North Line, at 6½ Points Diſtance from it, and thro' A draw AB parallel to CD, meeting CB in B; the ENE½E Line CB, will be the Courſe of the Ship upon the Starboard Tack, and CB it's Diſtance on that Tack; alſo the ESE½E Line AB, will be the Courſe on the Larboard Tack, and BA the Diſtance on that Tack. To find which



By Calculation.

In the Triangle ABC are given, the Angle ACB equal to 16°, 53′, the Diſtance between the Eaſt and ENE½E Line, the Angle CBA equal to 146°, 14′, the Diſtance between the ENE½E and the WNW½W Lines, the Angle BAC equal to 16°, 53′, the Diſtance between the Eaſt and SSE½E Lines, alſo AC 86 Miles.

Hence ſince the Angles at A and C are equal, the Legs CB and BA will likewiſe be equal; to find either of which (ſuppoſe CB) it will be, by *Caſe* 2. *of Oblique-angled Trigonometry*,

As the Sine of B - 146°, 14′ - - - - 9.74493
is to A C - - - - 86 - - - - - - 1.93450
ſo is the Sine of A - 16°, 53′ - - - 9.46303
to C B - - - - - 44.94 - - - 1.65260
the Diſtance the Ship muſt ſail on each Tack.

A great Variety of uſeful Queſtions of this Kind may be propoſed, but the Nature of them being better underſtood by Practice at Sea, we ſhall leave them and go on to *Current Sailing.*

SECT. XII.

Concerning Currents, *and how to make proper Allowances for them.*

1. CURRENTS are certain Settings of the *Stream*, by which all Bodies (as Ships, *&c.*) moving therein, are compelled to alter their Courſe or Velocity, or both; and ſubmit to the Motion impreſſed upon them by the Current.

CASE 1.

If the Current ſets juſt with the Courſe of the Ship, (*i. e.*) moves on the ſame Rumb with it; then the Motion of the Ship is increaſed, by as much as is the Drift or Velocity of the Current.

Example.

Suppoſe a Ship ſails S E *b* S at the Rate of 6 Miles an Hour, in a Current that ſets S E *b* S 2 Miles an Hour; required her true Rate of ſailing.

Here it is evident that the Ship's true Rate of ſailing will be 8 Miles an Hour.

CASE

CASE 2.

If the Current ſets directly againſt the Ship's Courſe; then the Motion of the Ship is leſſened by as much as is the Velocity of the Current.

Example.

Suppoſe a Ship ſails S S W at the Rate of 10 Miles an Hour, in a *Current* that ſets N N E 6 Miles an Hour; required the Ship's true Rate of ſailing.

Here it is evident that the Ship's true Rate of ſailing will be 4 Miles an Hour. Hence it is plain,

Cor. 1. If the Velocity of the *Current* be leſs than the Velocity of the Ship, then the Ship will get ſo much a *Head* as is the Difference of theſe Velocities.

Cor. 2. If the Velocity of the *Current* be greater than that of the Ship, then the Ship will fall ſo much a *Stern* as is the Difference of theſe Velocities.

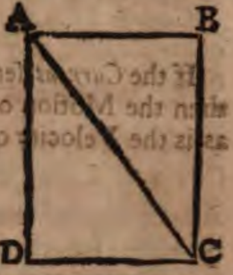
Cor. 3. *Laſtly*, if the Velocity of the Current be equal to that of the Ship, then the Ship will ſtand ſtill; the one Velocity deſtroying the other.

CASE 3.

If the *Current* thwarts the *Courſe* of the Ship, then it not only leſſens or augments her Velocity, but gives her a new Direction compounded of the Courſe ſhe ſteers, and the Setting of the *Current*, as is manifeſt from the following

Lemma.

If a Body at A be impelled by two Forces at the ſame Time, the one in the Direction A B [illegible] [illegible] pable to carry that Body from A to B in a certain Space of Time, and the other in the Direction AD capable to carry it from A to D in the ſame Time: Complete the Parallelogram A B CD, and draw the Diagonal A C; then the Body at A agitated by theſe two Forces together, will move along the Line A C, and will be in the Point C at the End of the Time in which it would have moved along A D or A B with the Forces ſeparately applied.



Hence the Solution of the following Examples will be evident.

Example 1.

Suppoſe a Ship ſails (by the Compaſs) directly South 96 Miles in 24 Hours, in a *Current* that ſets Eaſt 45 Miles in the ſame Time; required the Ship's true Courſe and Diſtance.

Geometrically.

Draw A D (ſee the laſt Scheme) to repreſent the South and North Line of the Ship at A, which make equal to 96; from D draw D C perpendicular to A D equal to 45, and join A C. Then C will be the Ship's true Place, A C her true Diſtance, and the Angle C A D the true Courſe. To find which

By Calculation.

Firſt, For the true Courſe D A C, it will be, by *Caſe* 4. *of Rectangular Trigonometry*,

As the apparent Diſtance A D	-	96	-	1.98227
is to the Current's Motion D C		45	-	1.65321

ſo

ſo is Radius		10.00000
to the Tangent of the true Courſe D A C	25°, 07′	9.67094

conſequently the Ship's true Courſe is S 25°, 07′ E. or S S E 2°, 37′ Eaſterly.

Then for the true Diſtance A C, it will be, by *Caſe 2. of Rectangular Trigonometry,*

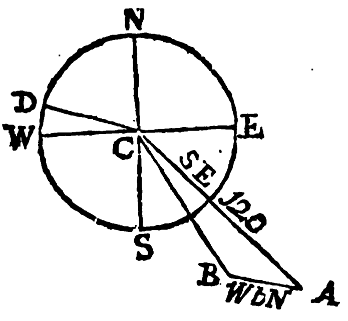
As the Sine of the Courſe A	25°, 07′	9.62784
is to the Departure D C	45	1.65321
ſo is Radius		10.00000
to the true Diſtance A C	106	2.02537

Example 2.

Suppoſe a Ship ſails S E 120 Miles in 20 Hours, in a Current that ſets W *b* N at the Rate of 2 Miles an Hour; required the Ship's true Courſe and Diſtance ſailed in that Time.

Geometrically.

Having drawn the Compaſs N E S W, let C repreſent the Place the Ship ſailed from; draw the South



Eaſt Line C A, which make equal to 120; then will A be the Place the Ship 'caped at.

From A draw A B parallel to the W *b* N Line C D, equal to 40, the Motion of the Current in 20 Hours, and join C B; then B will be the Ship's true Place at the End of 20 Hours, C B her true Diſtance, and the Angle S C B her true Courſe. To find which

By Calculation.

In the Triangle A B C, are given C A 120, A B 40, and the Angle C A B equal to 33°, 45′, the Diſtance between the E *b* S and S E Lines, to find the Angles B and C, and the Side C B.

Firſt, For the Angles C and B it will be, by *Caſe* 4. *of Oblique Trigonometry*,

As the Sum of the Sides C A and A B 160 2.20412
is to their Difference - - - - - 80 1.90309
ſo is the Tang. of half the Sum of the Angles B and C } 73°, 07′ 10.51783
to the Tang. of half their Diff. 58°, 45′ 10.21680

conſequently the Angle B will be 131°, 52′, and the Angle A C B 14°, 23′. Hence the true Courſe is S 30°, 37′ E, or S S E 2°, 07′ Eaſterly.

Then for the true Diſtance C B it will be, by *Caſe* 2. *of Oblique Trigonometry*,

As the Sine of B - - 131°, 52′ - 9.87198
is to A C - - - - - - 120 - - - 2.07918
ſo is the Sine of A - - 33°, 45′ - - 9.74474
to the true Diſtance C B 89.53 - - 1.95194

Example 3.

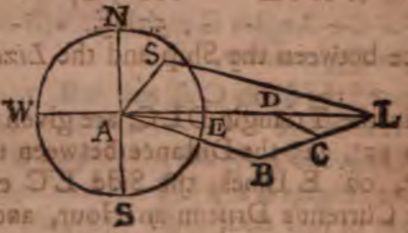
Suppoſe a Ship coming out from Sea in the Night, has Sight of *Scilly* Light, bearing N E *b* N Diſtance 4 Leagues, it being then Flood Tide ſetting E N E 2 Miles an Hour, and the Ship running after the Rate of 5 Miles an Hour; required upon what

Courſe and how far ſhe muſt ſail to hit the *Lizard*, which bears from *Scilly* E ½ S Diſtance 17 Leagues.

Geometrically.

Having drawn the Compaſs N E S W, let A repreſent the Ship's Place at Sea, and draw the N E *b* N Line A S, which make equal to 12 Miles, ſo S will repreſent *Scilly*.

From S draw S L equal to 51 Miles, and parallel to the E ½ S Line; then L will repreſent the *Lizard*.



From L draw L C parallel to the E N E Line, equal to 2 Miles, and from C draw C D equal to 5 Miles meeting A L in D; then from A draw A B parallel to C D meeting L C produced in B; and A B will be the required Diſtance, and S A B the true Courſe. To find which

By Calculation.

In the Triangle ASL are given the Side AS equal to 12 Miles, the Side SL equal to 51, and the Angle ASL equal to 118°, 07′, the Diſtance between the N E *b* N and W ½ N Lines, to find the Angles SAL and SLA. Conſequently, by *Caſe* 4. *of Oblique Trigonometry*, it will be,

As the Sum of the Sides A S and S L 63 1.79934
is to their Difference - - - - - 39 1.59106
ſo is the Tang. of half the Sum of the Angles S A L and S L A } 30°, 56′ 9.77763
to the Tang. of half their Diff. - 20°, 21′ 9.56935
conſequently the Angle S A L will be 51°, 17′, and ſo the direct Bearing of the *Lizard* from the Ship, will be N 85°, 02′ Eaſt, or E *b* N 6°, 17′ E, and for the Diſtance A L, it will be, by *Caſe* 2. *of Oblique Trigonometry,*

As the Sine of S A L - - 51°, 17′ - 9.89223
is to S L - - - - - 51 - - - 1.70757
ſo is the Sine of A S L - 118°, 07′ - 9.94546
to A L - - - - - - - 57.65 - - 1.76080
the Diſtance between the Ship and the *Lizard.*

Again, in the Triangle D L C, are given the Angle L equal to 17°, 32′, the Diſtance between the E N E and N 85°, 02′ E Lines, the Side L C equal to 2 Miles, the Current's Drift in an Hour, and the Side C D equal to 5 Miles the Ship's Run in the ſame Time. Hence for the Angle D, it will be, by *Caſe* 1. *of Oblique Trigonometry,*

As the Ship's Run in 1 Hour D C 5 - 0.69897
is to the Sine of L - - - - 17°, 32′ 9.47894
ſo is the Current Drift L C - - 2 - 0.30103
to the Sine of D - - - - - 6°, 55′ 9.08100
conſequently ſince by Conſtruction the Angle L A B is equal to the Angle L D C, the Courſe the Ship muſt ſteer is S 88°, 03′ E.

Then for the Diſtance A B it will be, by *Caſe* 2. *of Oblique Trigonometry,*

As the Sine of B - - 155°, 33′ - - 9.61689
is to A L - - - - - 57.65 - - 1.76080
ſo is the Sine of L - - 17°, 32′ - - 9.47894
to A B - - - - - - 41.96 - - 1.62285

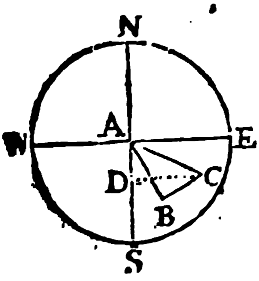
conſequently ſince the Ship is ſailing at the Rate of 5 Miles an Hour, it follows; that in ſailing 8^h, 24^m S 88°, 05′ E, ſhe will arrive at the *Lizard.*

Example 4.

A Ship from a certain Headland in the Latitude of 34°, 00′ North, ſails S E *b* S 12 Miles in three Hours, in a Current that ſets between North and Eaſt, and then the ſame Headland is found to bear W N W, and the Ship to be in the Latitude of 33°, 52′ North; required the Setting and Drift of the Current.

Geometrically.

Having drawn the Compaſs N E S W, let A repreſent the Place of the Ship, and draw the S E *b* S Line A B equal to 12 Miles, alſo the E S E Line A C.



Set off from A upon the Meridian A D, equal to 8 Miles, the Difference of Latitude, and thro' D draw D C parallel to the Eaſt and Weſt Line W E, meeting A C in C. Join C and B with the right Line B C; then C will be the Ship's Place, the Angle A B C the Setting of the Current from the S E *b* S Line, and the Line B C will be the Drift of the Current in 3 Hours. To find which

By Calculation.

In the Triangle A D C, right-angled at D, are given the Difference of Latitude A D equal to 8 Miles, the Angle D A C equal to 67°, 30′. Whence for A C the Diſtance the Ship has ſailed, it will be,

As Radius - - - - - - - - - - - - 10.00000
is to the Diff. of Latitude AD - 8 - 0.90309
ſo is the Secant of the Courſe DAC - - - - - - - 67°, 30′ 10.41716
to the Diſtance run AC - - 20.9 - 1.32025

Again, in the Triangle ABC, are given AB equal to 12 Miles, AC equal to 20.9, and the Angle BAC equal to 33°, 45′, the Diſtance between the SE*b*S and ESE Lines: Whence for the Angle at B it will be;

As the Sum of the Sides AC and AB 32.9 1.51720
is to their Difference - - - - - - 8.9 0.94939
ſo is the Tangent of Half the Sum of the Angles B and C 73°, 07′ - 10.51806
to Tang. of ½ their Diff. - 41°, 43′ ½ - 9.95025

conſequently the Angle B is 114°, 51′, and ſo the ſetting of the Current will be N 81°, 06′ E, or E*b*N 2°, 21′ E. Then for BC the Current's Drift in 3 Hours it will be,

As the Sine of B - - 114°, 51′ - - 9.95780
is to the Diſtance run AC 20.9 - - - 1.32025
ſo is the Sine of A - 33°, 45′ - - 9.74474
to BC - - - - - - - 12.8 - - - 1.10719

the Current's Drift in 3 Hours, and conſequently the Current ſets E*b*N 2°, 21′ E 4.266 Miles an Hour.

SECT. XIII.

Concerning the Variation *of the* Compaſs, *and how to find it from the true and obſerved* Amplitudes, *or* Azimuths *of the Sun.*

1. THE *Variation* of the Compaſs is, how far the North or South Point of the *Needle* ſtands from the true South or North Point of the Horizon, towards the Eaſt or Weſt; or 'tis an Arch of the Horizon, intercepted between the Meridian of the Place of Obſervation and the magnetic Meridian.

2. It is abſolutely neceſſary to know the *Variation* of the Compaſs at Sea, in order to correct the Ship's Courſe; for ſince the Ship's Courſe is directed by the Compaſs, 'tis evident that if the Compaſs be wrong, the true Courſe will differ from the obſerved, and conſequently the whole Reckoning differ from the Truth.

3. The Sun's true *Amplitude* is an Arch of the Horizon comprehended between the true Eaſt or Weſt Point thereof, and the Center of the Sun at Riſing or Setting; or it is the Number of Degrees, *&c.* that the Center of the Sun is diſtant from the true Eaſt or Weſt Point of the Horizon, towards the South or North.

4. The Sun's *magnetic Amplitude* is the Number of Degrees that the Center of the Sun is from the Eaſt or Weſt Point of the Compaſs, towards the South or North Point of the ſame at Riſing or Setting.

5. Having the Declination of the Sun, together with the Latitude of the Place of Obſervation, we may from thence find the Sun's true Amplitude, by the following aſtronomical Propoſition, *viz.*

As the Co-ſine of the Latitude
is to the Radius,

ſo is the Sine of the Sun's Declination
to the Sine of the Sun's true Amplitude;

which will be North or South, according as the Declination is North or South.

Example.

Required the Sun's true Amplitude in the Latitude of 51°, 50′ North, on the 4th Day of *May*, 1771.

Firſt, I find from the third Table at the End of this Book, that the Sun's Declination the 4th of *May*, 1771, is 15°, 56′ North; then for the true Amplitude it will be, by the former Analogy,

As the Co-ſine of the Lat.	41°, 50′	-	9.87221
is to Radius - - - - - - - - - -		-	10.00000
ſo is the Sine of the Decl.	15°, 56′	-	9.43857
to the Sine of the Amplit.	21°, 37′	-	9.56636

which is North, becauſe the Declination is North at that Time; and conſequently in the Latitude of 41°, 50′ North, the Sun riſes on the 4th of *May*, 1771, 21°, 37′, from the Eaſt Part of the Horizon towards the North, and ſets ſo much from the Weſt the ſame Way.

6. The Sun's true *Azimuth* is the Arch of the Horizon, intercepted between the Meridian and the vertical Circle paſſing through the Center of the Sun at the Time of Obſervation.

7. The Sun's *magnetic Azimuth* is the Arch of the Horizon intercepted between the magnetic Meridian and the vertical, paſſing through the Sun.

8. Having the Latitude of the Place of Obſervation, together with the Sun's Declination and Altitude at the Time of Obſervation, we may find his true Azimuth after the following Manner, *viz.*

Make

Make it,

As the Tangent of Half the Complement of the Latitude,
is to the Tangent of Half the Sum of the Diſtance of the Sun from the Pole and Complement of the Altitude;
ſo is the Tangent of Half the Difference between the Diſtance of the Sun from the Pole and Complement of the Altitude
to the Tangent of a fourth Arch:

Which fourth Arch added to half the Complement of the Latitude, will give a fifth Arch; and this fifth Arch leſſened by the Complement of the Latitude, will give a ſixth Arch. Then make it,

As the Radius
is to the Tangent of the Altitude,
ſo is the Tangent of the ſixth Arch
to the Co-ſine of the Sun's Azimuth;

which is to be counted from the South or North, to the Eaſt or Weſt, according as the Sun is ſituated with reſpect to the Place of Obſervation.

If the Latitude of the Place and Declination of the Sun be both North or both South, then the Declination taken from 90° will give the Sun's Diſtance from the Pole; but if the Latitude and Declination be on contrary Sides of the Equator, then the Declination added to 90° will give the Sun's Diſtance from the neareſt Pole to the Place of Obſervation.

Example.

In the Latitude of 51°, 32′ North, the Sun having 19°, 39′ North Decl. his Altitude was found by Obſervation to be 38°, 18′; required the Azimuth.

By the firſt of the foregoing Analogies it will be,

As the Tangent of ½ the Complement of the Latitude -	19°, 14′	9.54269
is to the Tangent of ½ the Sum of the Diſtance of the Sun from the Pole and Complement of the Altitude - -	61 , 01	10,25655
ſo is the Tangent of half their Difference - - - - - -	9 , 19	9,21499
to the Tang. of a 4th Arch -	40 , 20	9.92885

which fourth Arch 40°, 20′, added to 19°, 14′, half the Complement of the Latitude, gives a fifth Arch 59°, 34′; and this fifth Arch leſſened by 38°, 28′, the Complement of the Latitude, gives the ſixth Arch 21°, 06′: Then for the Azimuth it will be, by the ſecond of the preceding Analogies,

As Radius - - - - - - - - - -		10.00000
is to the Tang. of the Altitude	38°, 18′	9.89749
ſo is the Tang. of the ſixth Arch	21 , 06	9.58644
to the Co-ſine of the Azimuth	72 , 15	9.48393

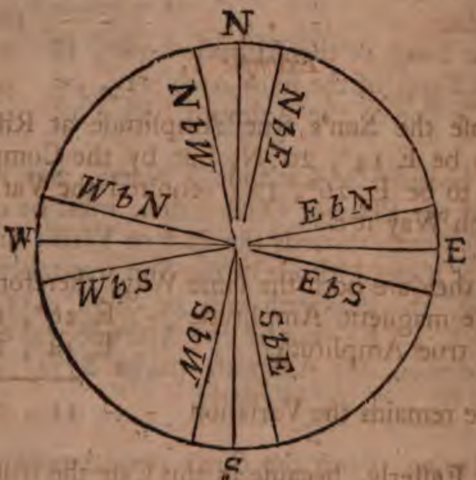
which, becauſe the Latitude is North, and the Sun South of the Place of Obſervation, muſt be counted from the South towards the Eaſt or Weſt; and conſequently if the Altitude of the Sun was taken in the Morning, the Azimuth will be S 72°, 15′ E, or E S E 4°, 45′ E; but if the Altitude was taken in the Afternoon, the Azimuth will be S 72°, 15′ W, or W S W 40°, 45′ Weſterly.

9. Having found the Sun's true Amplitude, or Azimuth, by the preceding Analogies, and his magnetic Amplitude, or Azimuth, by Obſervation, 'tis evident, if they agree, there is no *Variation*; but if they diſagree, then if the true and obſerved Amplitudes at the Riſing or Setting of the Sun, be both

of the ſame Name, *i. e.* either both North, or both South, their Difference is the *Variation*: But if they be of different Names, *i. e.* one North and the other South, their Sum is the *Variation.* Again, if the true and obſerved Azimuths be both of the ſame Name, *i. e.* either both Eaſt or both Weſt, their Difference is the *Variation*; but if they be of different Names, their Sum is the *Variation*: And to know whether the *Variation* is *Eaſterly* or *Weſterly*, obſerve this general Rule, *viz.*

Let the Obſerver's Face be turned to the Sun, then if the true Amplitude or Azimuth be to the Right-hand of the Obſerved, the *Variation* is Eaſterly; but if to the left, Weſterly.

To explain which, let N E S W repreſent a Compaſs, and ſuppoſe the Sun is really E *b* S at the Time of Obſervation, but the Obſerver ſees him off the



Eaſt Point of the Compaſs, and ſo the true Amplitude or Azimuth of the Sun, is to the right of the Magnetic, or Obſerved; here 'tis evident, that the E *b* S Point of the Compaſs ought to lie where the Eaſt Point is, and ſo the North where the N *b* W is; conſequently the North Point of the Compaſs is a Point too far Eaſt, *i. e.* the Variation in this Caſe is Eaſterly. The ſame will hold when the Amplitude or Azimuth is taken on the Weſt Side of the Meridian.

Again, let the true Amplitude or Azimuth be to the Left-hand of the Obſerved: Thus ſuppoſe the Sun is really E *b* N at the Time of Obſervation, but the Obſerver ſees him off the Eaſt Point of the Compaſs, and ſo the true Amplitude or Azimuth to the Left of the Obſerved. Here it is evident, that the E *b* N Point of the Compaſs ought to ſtand where the Eaſt Point is, and ſo the North where the N *b* E Point is; conſequently the North Point of the Compaſs lies a Point too far Weſterly, ſo in this Caſe the Variation is Weſt. The ſame will hold when the Sun is obſerved on the Weſt Side of the Meridian.

Example 1.

Suppoſe the Sun's true Amplitude at Riſing is found to be E 14°, 20′ N, but by the Compaſs it is found to be E 26°, 12′; required the Variation, and which Way it is.

Since they are both the ſame Way, therefore
From the magnetic Amplitude - E 26°, 12′ N.
take the true Amplitude - - - E 14 , 20 N.

and there remains the Variation - - 11 , 52 E.

which is Eaſterly, becauſe in this Caſe the true Amplitude is to the Right of the Obſerved.

Example 2.

Suppoſe the Sun's true Amplitude at Setting is W 34°, 26′ S, and his magnetic Amplitude W 23°, 13′ S; required the Variation, and which Way it is.

Since they lie both the ſame Way, therefore

From the Sun's true Amplitude - W 34°, 26′ S.
take the magnetic Amplitude - W 23 , 13 S.

there remains the Variation - - - 11 , 13 W.

which is Weſterly, becauſe the true Amplitude, in this Caſe, is to the Left-hand of the Obſerved.

Example 3.

Suppoſe the Sun's true Altitude at Riſing is found to be E 13°, 24′ N, and his Magnetic E 12°, 32′ S; required the Variation, and which Way it lies.

Since the true and obſerved Amplitudes lie different Ways, therefore

To the Amplitude - - - - - E 13°, 24′ N.
add the magnetic Amplitude - - E 12 , 32 S.

the Sum is the Variation - - - - 25 , 56 W.

which is Weſterly, becauſe the true Amplitude is, in this Caſe, to the Left of the Obſerved.

Example 4.

Suppoſe the Sun's true Amplitude at Setting is found to be W 80°, 24′ N, but his magnetic Amplitude is W 10°, 13′ S; required the Variation.

To the true Amplitude - - - W 8°, 24′ N.
add the magnetic - - - - W 10 , 13 S.

the Sum is the Variation - - - 18 , 37 E.

which is Eaſterly, becauſe the true Amplitude is to the Right of the Obſerved.

Example 5.

Suppoſe the Sun's true Azimuth at the Time of Obſervation, is found to be N 86°, 40′ E, but by the Compaſs it is N 73°, 24′ E; required the Variation, and which Way it lies.

From the Sun's true Azimuth - N 86°, 40′ E.
take the magnetic - - - - - N 73 , 24 E.

there remains the Variation - - - 13 , 16 E.

which is Eaſterly, becauſe the true Azimuth is to the Right of of the Obſerved.

Example 6.

Suppoſe the Sun's true Azimuth is S 3°, 24′ E; and the Magnetical S 4°, 36′ W; required the Variation, and which Way it lies.

To the true Azimuth - - - - S 3°, 36′ E.
add the magnetic Azimuth - - - S 4 , 36 W.

the Sum is the Variation - - - - 8 , 00′ W.

which is Weſterly, becauſe the true Azimuth is, in this Caſe, to the Left of the Obſerved.

10. The Variation of the Compaſs was firſt obſerved at *London*, in the Year 1580, to be 11°,

15′

15′ Eaſterly, and in the Year 1622 it was 6°, 0′ E, alſo in the Year 1634, it was 4°, 05′ E, ſtill decreaſing, and the Needle approaching the true Meridian, 'till it coincided with it, and then there was no Variation; after which, the Variation began to be Weſterly, and in the Year 1672, it was obſerved to be 2°, 30′ W, alſo in the Year 1683, it was 4°, 30′ W, and ſince that Time the Variation ſtill continues at *London* to increaſe Weſterley; but how far it will go that Way, Time and Obſervations will probably be the only Means to diſcover.

Again, at *Paris*, in the Year 1640, the Variation was 3°, 00′ E, and in the Year 1666, there was no Variation; but in the Year 1681, it was 2°, 30′ W, and ſtill continues to go Weſterly.

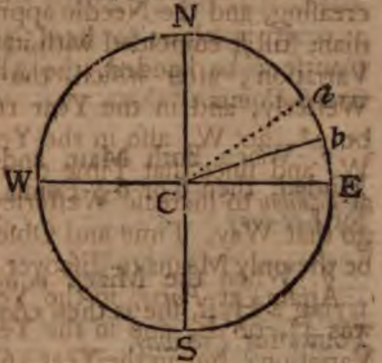
In ſhort, from Obſervations made in different Parts of the World, it appears, that in different Places the Variation differs both as to it's Quantity and Denomination, it being Eaſt in one Place, and Weſt in another; the true Cauſe and Theory of which, for Want of a ſufficient Number of Obſervations, has not as yet been fully explained.

SECT. XIV.

The Method of Keeping a Journal at Sea, and how to correct it, by making proper Allowances for the Lee-way, Variation, *&c.*

1. *LEE-WAY* is the Angle that the Rumb Line upon which the Ship endeavours to ſail, makes with the Rumb ſhe really ſails upon. This is occaſioned by the Force of the Wind, or Surge of the Sea, when ſhe lies to the windward, or is cloſe hauled, which cauſes her to fall off and

glide Side-ways from the Point of the Compaſs ſhe capes at. Thus let N E S W repreſent the Compaſs, and ſuppoſe a Ship at C capes at, or endeavours to ſail upon, the Rumb C *a*; but by the Force of the Wind, and Surge of the Sea, ſhe is obliged to fall off, and make her Way good upon the Rumb C *b*; then the Angle *a* C *b* is the *Lee-way*, and if that Angle be equal to one Point, the Ship is ſaid to make one Point *Lee-way*, and if equal to two Points, the Ship is ſaid to make two Points *Lee-way*, &c.



2. The Quantity of this Angle is very uncertain, becauſe ſome Ships, with the ſame Quantity of Sail, and with the ſame Gale, will make more *Lee-way* than others; it depending much upon the Mould and Trim of the Ship, and the Quantity of Water that ſhe draws. The common Allowances that are generally made for the *Lee-way*, are as follow:

1. If a Ship be cloſe-hauled, has all her Sails ſet, the Water ſmooth, and a moderate Gale of Wind, ſhe is then ſuppoſed to make little or no *Lee-way*.

2. If it blows ſo freſh as to cauſe the ſmall Sails to be handed, 'tis uſual to allow one Point.

3. If it blows ſo hard that the Top-ſails muſt be cloſe reeft, then the common Allowance is two Points for *Lee-way*.

4. If the Top-ſail muſt be handed, then the Ship is ſuppoſed to make between two and three Points *Lee-way*.

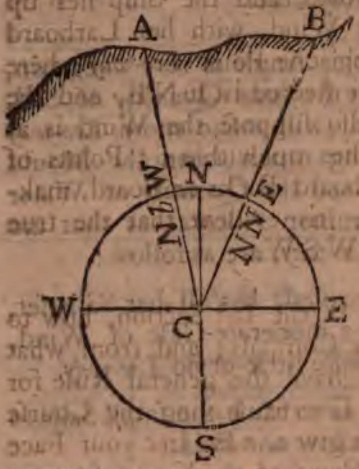
5. When both Top-ſails muſt be handed, then the Allowance is about four Points for *Lee-way*.

6. If it blows ſo hard, as to occaſion the Fore-Courſe to be handed, the Allowance is between $5\frac{1}{2}$ and 6 Points.

7. When both Main and Fore-Courſes muſt be handed, then 6 or $6\frac{1}{2}$ Points are commonly allowed for *Lee-way*.

8. When the Mizen is handed, and the Ship is trying a Hull, ſhe is then commonly allowed about 7 Points for *Lee-way*.

3. Though theſe Rules are ſuch as are generally made uſe of, yet ſince the *Lee-way* depends much upon the Mould and Trim of the Ship, 'tis evident that they cannot exactly ſerve to every Ship; and therefore the beſt Way is to find it by Obſervation: Thus, let the Ship's *Wake* be ſet by a *Compaſs* in the *Poop*, and the oppoſite *Rumb* is the true *Courſe* made good by the Ship; then the Difference between this and the Courſe given by the *Compaſs* in the *Bittacle*, is the *Lee-way* required. If the Ship be within Sight of Land; then the *Lee-way* may be exactly found, by obſerving a Point on the Land which continues to bear the ſame Way, and the Diſtance between the Point of the Compaſs it lies upon, and the Point the Ship capes at, will be the *Lee-way*. Thus, ſuppoſe a Ship at C, is lying up N *b* W towards A; but



but inſtead of keeping that Courſe, ſhe is carried on the N N E Line C B, and conſequently the Point B continues to bear the ſame Way from the Ship: Here 'tis evident, that the Angle A C B, or the Diſtance between the N *b* W Line that the Ship capes at, and the N N E Line that the Ship really ſails upon, will be the *Lee-way*.

4. Having the Courſe ſteered, and the *Lee-way* given, we may from thence find the true Courſe by the following Method, *viz.* Let your Face be turned directly to the Windward, and if the Ship has her Larboard Tacks on Board, count the *Lee-way* from the Courſe ſteered towards the Right-hand; but if the Starboard Tacks be on Board, then count it from the Courſe ſteered towards the Left-hand. Thus ſuppoſe the Wind at North, and the Ship lies up within 6 Points of the Wind, with her Larboard Tacks on Board, making one Point *Lee-way*; here 'tis plain, that the Courſe ſteered is E N E, and the true Courſe E *b* N; alſo ſuppoſe the Wind is at N N W, and the Ship lies up within $6\frac{1}{2}$ Points of the Wind with her Starboard Tacks on Board, making $1\frac{1}{2}$ Point *Lee way*; 'tis evident that the true Courſe, in this Caſe, is W S W.

5. We have ſhewed, in the laſt Section, how to find the Variation of the Compaſs; and from what has been ſaid there, we have this general Rule for finding the Ship's true Courſe, having the Courſe ſteered and the Variation given, *viz.* Let your Face be turned towards the Point of the Compaſs upon which the Ship is ſteered; and if the Variation be Eaſterly, count the Quantity of it from the Courſe ſteered, towards the Right-hand; but if Weſterly, towards the Left-hand; and the Courſe thus found, is the true Courſe ſteered. Thus, ſuppoſe the Courſe ſteered is N *b* E, and the Variation one Point Eaſterly;

then the true Courſe ſteered, will be N N E: Alſo ſuppoſe the Courſe ſteered is N E *b* E, and the Variation one Point Weſterly; then in this Caſe, the true Courſe will be N E, and ſo of others.

Hence, by knowing the *Lee-way*, *Variation*, and *Courſe* ſteered, we may from thence find the Ship's true Courſe; but if there be a Current under Foot, then that muſt be tried and proper Allowances made for it, as has been ſhewn at *Sect.* XII. from thence to find the true Courſe.

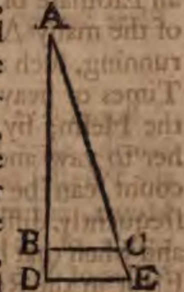
6. After making all the proper Allowances for finding the Ship's true Courſe, and making as juſt an Eſtimate of the Diſtance as we can; yet by reaſon of the many Accidents that attend a Ship in the Day's running, ſuch as different Rates of ſailing between the Times of heaving the Log, the Want of due Care at the Helm, by not keeping her ſteady, but ſuffering her to yaw and fall off, ſudden Storms when no Account can be kept, &c. the Latitude, by Account, frequently differs from the Latitude by Obſervation, and when that happens, 'tis evident there muſt be ſome Error in the Reckoning; to diſcover which and where it lies, and alſo how to correct the Reckoning, you may obſerve the following *Rules*.

1. If the Ship ſails near the Meridian, or within 2 or 2 ½ Points thereof; then if the Latitude by Account, diſagrees with the Latitude by Obſervation, 'tis moſt likely that the Error lies in the Diſtance run; for it is plain that in this Caſe it will require a very ſenſible Error in the Courſe, to make any conſiderable Error in the Difference of Latitude, which can't well happen if due Care be taken at the Helm, and proper Allowances be made for the *Lee-way*, *Variation*, and *Currents*. Conſequently if the Courſe be pretty near the Truth, and the Error in the Diſtance run

regularly thro' the whole, we may from the Latitude, obtained by Obſervation, correct the Diſtance and Departure by Account, by the following Analogies, *viz.*

As the Difference of Latitude by Account
is to the true Difference of Latitude,
ſo is the Departure by Account
to the true Departure,
and ſo is the direct Diſtance by Account
to the true direct Diſtance.

The Reaſon of this is plain; for let A B denote the Meridian of the Ship at A, and ſuppoſe the Ship ſails upon the Rumb A E near the Meridian, 'till by Account ſhe is found in C, and conſequently her Difference of Latitude by Account is A B; but by Obſervation ſhe is found in the Parallel E D, and ſo her true Difference of Latitude is A D, her true Diſtance A E, and her true Departure D E; then ſince the Triangles A B C, A D E are ſimilar, it will be A B : A D :: B C : D E and A B : A D :: A C : A E.



Example.

Suppoſe a Ship from the Latitude of 45°, 20′ North, after having ſailed upon ſeveral Courſes near the Meridian for 24 Hours, her Difference of Latitude is computed to be upon the whole 95 Miles Southerly, and her Departure 34 Miles Eaſterly; but by Obſervation ſhe is found to be in Latitude of 43°, 10′ North, and conſequently her true Difference of Latitude is 130 Miles Southerly; then for the true Departure it will be, As the Difference of Latitude by Account 95, is to the true

Difference of Latitude 130, ſo is the Departure by Account 34, to the true Departure 46.52, and ſo is the Diſtance by Account 100.9, to the true Diſtance 138.

2. If the Courſes are for the moſt part near the Parallel of Eaſt and Weſt, and the direct Courſe be within 5 ½ or 6 Points of the Meridian; then if the Latitude by Account differs from the obſerved Latitude, it is moſt probable that the Error lies in the Courſe or Diſtance, or perhaps both; for in this Caſe 'tis evident, the Departure by Account will be very nearly true; and thence, by the Help of this, and the true Difference of Latitude, may the true Courſe and direct Diſtance be readily found by *Caſe* 4. *of Plane Sailing*.

Example.

Suppoſe a Ship from the Latitude of 43°, 50′ North, after having ſailed upon ſeveral Courſes near the Parallel of Eaſt and Weſt, for the Space of 24 Hours, is found by dead Reckoning to be in the Latitude of 42°, 45′ North, and to have made 160 Miles of Weſting; but by a good Obſervation the Ship is found to be in the Latitude of 42°, 35′ North; required the true Courſe and direct Diſtance ſailed.

With the true Difference of Latitude 75 Miles, and Departure 160 Miles, we ſhall find (by *Caſe* 4. *of Plane Sailing*) the true Courſe to be S 64°, 53′ W, and the direct Diſtance 176.7 Miles.

3. If the Courſes are for the moſt part near the middle of the Quadrant, and the direct Courſe within 2 and 6 Points of the Meridian; then the Error may be either in the Courſe, or in the Diſtance, or in both, which will cauſe an Error both in the Difference of Latitude and Departure;

ture, to correct which, having found the true Difference of Latitude by Obſervation; with this, and the direct Diſtance by dead Reckoning, find a new Departure (*by Caſe* 3. *of Plane Sailing*) then half the Sum of this Departure, and that by dead Reckoning, will be nearly equal to the true Departure; and conſequently with this, and the true Difference of Latitude, we may (*by Caſe* 4. *of Plane Sailing*) find the true Courſe and Diſtance.

Example.

Suppoſe a Ship from the Latitude of 44°, 38′ North, ſails between *South* and *Eaſt* upon ſeveral Courſes, near the Middle of the Quadrant, for the Space of 24 Hours, and is then found, by dead Reckoning to be in the Latitude of 42°, 15′ North, and to have made of Eaſting 136 Miles; but by Obſervation ſhe's found to be in the Latitude of 42°, 4′ North. Required her true Courſe and Diſtance.

With the true Diſtance of Latitude 154 Miles, and the direct Diſtance by dead Reckoning 197.4 you'll find (*by Caſe* 3. *of Plane Sailing*) the new Departure to be 123.4, and half the Sum of this, and the Departure by dead Reckoning, will be 129.7 the true Departure; then with this, and the true Difference of Latitude, you'll find (*by Caſe* 4. *of Plane Sailing*) the true Courſe to be S 40°, 7′ E, and the direct Diſtance 200.9 Miles.

7. In keeping a Ship's Reckoning at Sea, the common Method is to take from the *Log-board*, the ſeveral Courſes and Diſtances ſtemmed by the Ship the laſt 24 Hours, and to transfer theſe together with the moſt remarkable Occurrences into the *Log-Book*, in which alſo are inſerted the Courſes

corrected, and the Difference of Latitude and Difference of Longitude made good upon each; then the whole Day's Work being finiſh'd in the *Log-Book*, if the Latitude by Account agree with the Latitude by Obſervation, the Ship's Place will be truly determined; if not, then the Reckoning muſt be corrected according to the preceding Rules, and placed in the *Journal*.

The Form of the *Log-Book* and *Journal*, together with an Example of 2 Days Work, you have here ſubjoined.

Note, To expreſs the Days of the Week, they commonly uſe the Characters by which the Sun and Planets are expreſſed, *viz.* ☉ denotes *Sunday*, ☽ *Monday*, ♂ *Tueſday*, ☿ *Wedneſday*, ♃ *Thurſday*, ♀ *Friday*, and ♄ denotes *Saturday*.

THE FORM OF THE LOG-BOOK,

With the Manner of working Days
Works at *Sea*.

The Log-Book.

H.	K.	$\frac{1}{2}$K.	Courſes.	Winds.	Obſervations and Accidents. ☽ —— Day of ——
1					Fair Weather, at Four this Afternoon I took my Departure from the *Lizard*, in the Latitude of 5°, 00′ North, it bearing N N E, Diſtance five Leagues.
2				North	
3					
4					
5	7		S W *b* S	N *b* E	
6	7				
7	7	1			
8	7	1			
9	6				
10	6				
11	6		S S W	E *b* S	
12	6	1			The Gale increaſing, and being under all our Sails.
1	6	1			
2	6	1	SW*b*W	N N E	
3	6	1			After Three this Morning, frequent Showers with thick Weather till near Noon.
4	7				
5	7	1			
6	8				
7	8				
8	8		S W	E N E	
9	8	1			The Variation I reckon to be one Point Weſterly.
10	9				
11	8	1	SW$\frac{1}{2}$W	N E*b*E	
12	8				

The Log-Book.

Courſes correct.	Diſt.	Diff. Lat.		Diff. Long.	
		N	S	E	W
S S W	50		46.2		29.4
S *b* W	19		18.6		5.5
S W	49		29.7		45.5
S W *b* S	24.5		20.2		20.0
S W ½ S	25.5		19.5		24.6
			134.2		125.0

Hence the Ship, by Account, has come to the Latitude of 47°, 46′ North, and has differed her Longitude 2°, 5′ Weſterly; ſo this Day I have made my Way good S 31°, 31′ W. Diſtance 157.4 Miles.

At Noon the *Lizard* bore from me N 31°, 31′ E Diſtance 157.4 Miles, and having obſerved the Latitude, I found it agree with the Latitude by Account.

The Log-Book.

H.	K.	½K.	Courſes.	Winds.	Obſervations and Accidents. ♂ — Day of ——
1	2		S S W	W	This 24 Hours, ſtrong Gale of Wind, and variable.
2	1	1	Handed the Main and Fore Courſes, Lee-way 6 Points.		
3	1	1			
4	1	1			
5	1	1			
6	1				
7	1				
8	1	1	The Wind increaſing, we tried a Hull, Lee-way 7 Points.		The Variation I judge to be 1 Point Weſt.
9	1				
10	1				
11	1				
12	1	1			
1	2		S W*b*W	N W*b*W	
2	1	1	Set main-Sail, Lee-way 4½ Points.		
3	1				
4	1				
5	1				
6	1	1			
7	1				
8	4		S*b*E	S W*b*W	
9	4	1	Set Fore-ſail, Lee-way 3 Points.		
10	4	1			
11	5				Lat. by Obſervation, 47°, 06′ N.
12	4	1			

The Log-Book.

Courſes Correct.	Diſt.	Diff. Lat.		Diff. Long.	
		N	S	E	W
S E *b* E	32.5		17.8	37.7	
E S E	6		2.3	10.6	
S ½ E	9		8.9	1.3	
			29.0	49.6	

Hence the Ship, by Account, has come to the Latitude of 47°, 17′ North, and has differed her Longitude 49′ Eaſterly; conſequently ſhe has got 1°, 16′ to the Weſtward of the *Lizard*, and has made her Way good the laſt 24 Hours, S 49°, 08′ E, Diſtance 44.3 Miles.

At Noon the *Lizard* bore from me North 17°, 7′ Eaſt, Diſtance 170.6 Miles.

This Day I had an Obſervation, and found the Latitude by Account to diſagree with the Latitude by Obſervation by 11 Minutes, I being ſo much further to the Southward than by Dead Reckoning, which by the third of the preceding Rules I correct as in the *Journal.*

A JOURNAL *from the* Lizard *towards* Jamaica, *in the Ship* Neptune, *J. M. Commander.*

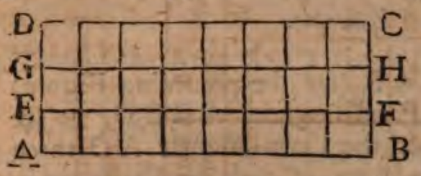
Week Days	Month Years	Month Days	Winds	Direct Courſe	Diſt. Miles.	Latitude correct.	Whole Diff. Long. made	Bearing and Diſt. from the *Lizard.*	Remarkable Obſervations & Accidents.
☽	——	——	N *b* E E *b* S N N E E N E N E *b* E	S 31, 31 W	157.4	47°, 46′	2°, 5′ W	At Noon the *Lizard* bore N 31°, 31′ E. Diſt. 157.4 Miles.	Fair Weather at four *P. M.* I took my Departure from the *Lizard*, it bearing N N E Diſtance 5 Leagues.
♂	——	——	Weſt N W *b* W S W *b* W	S 34, 01 E	48.2	47°, 06′	1°, 35′ W	At Noon the *Lizard* bore S 17°, 55′ W. Diſt. 183 Mil.	Strong Gales of Wind and variable.

SECT. XV.

Of MENSURATION.

Def. THE *Area* of any plane Surface in Inches, Feet, or any other Meaſure, is the Number of ſquare Inches, Feet, *&c.* that the Surface contains.

1. Let ABCD repreſent a rectangular Parallelogram, and ſuppoſe the Side AB, or DC, contains eight equal Parts, and the Side AD or BC three of the ſame Parts; then let the Line AB be moved along in the Direction of AD till it has come to EF, where AE or FB, the Diſtance of it from it's firſt Situation, may be equal to one of the equal Parts: Here 'tis evident, that the generated Parallelogram ABFE will contain as many Squares as the Side AB contains equal Parts (in this Caſe eight), each Square having for it's Side one of the equal Parts into which AB or AD is divided. Again, let AB move on till it comes to GH, ſo as GE or HF may be equal to AE or BF, then 'tis plain that the Parallelogram AGHB will contain twice as many Squares as the Side AB contains equal Parts, each Square having one of the equal Parts, into which AB or AD is divided, for it's Side; and by the ſame Way of Reaſoning it will appear, that the Parallelogram ADCB will contain three Times as many Squares as the Side AB contains equal Parts; and, in general, that every rectangular Parallelogram



contains as many Squares as the Product of the Number of equal Parts in the Baſe multiplied into the Number of the ſame equal Parts in the Height contains Units, each Square having for it's Side one of the equal Parts.

Hence ariſes the Solution of the following Problems.

Problem 1.

To find the Area of a rectangular Parallelogram.

Rule. Multiply the Baſe into the perpendicular Height, and the Product is the Area required.

Example.

Suppoſe the Baſe A B (ſee the preceding Figure) of the rectangular Parallelogram A B C D, is ſix Inches in Length, and the Perpendicular A D three Inches, required the Area of that Parallelogram in Inches.

6 the Baſe A B
3 the Perpendicular A D

Product 18 the Area of the Parallelogram A B C D in Inches.

Problem 2.

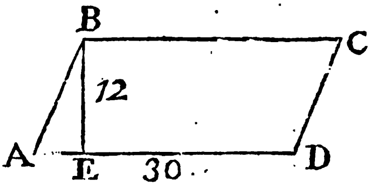
To find the Area of an Oblique-Angular-Parallelogram.

Rule. Multiply the Baſe into the perpendicular Height, and the Product is the Area. The Reaſon of this Rule is evident from *Art.* 69. *Sect.* I.

Example.

Example.

Suppoſe the Baſe AD of the Oblique-Angular Parallelogram ADCB, is 30 Inches, and the Perpendicular BE 12 Inches; required the Area in Inches.



Multiplying 30 the Baſe, into 12 the perpendicular Height, the Product 360, is the Area, or Number of ſquare Inches contained in the propoſed Figure.

Problem 3.

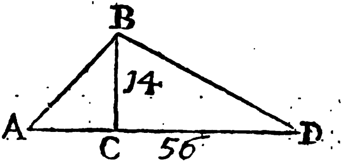
To find the Area of a Triangle.

Rule. Multiply the Baſe into half the perpendicular Height, and the Product is the Area required. The Reaſon of this Rule is plain from *Cor.* 3. *Art.* 68. *Sect.* I.

Example.

In the Triangle ABD, ſuppoſe the Baſe AD is 56 Feet, and the Perpendicular BC 14; required the Area.

The Baſe 56, multiplied into 7, half the Perpendicular, gives 391, the Area or ſquare Feet contained in the given Triangle.



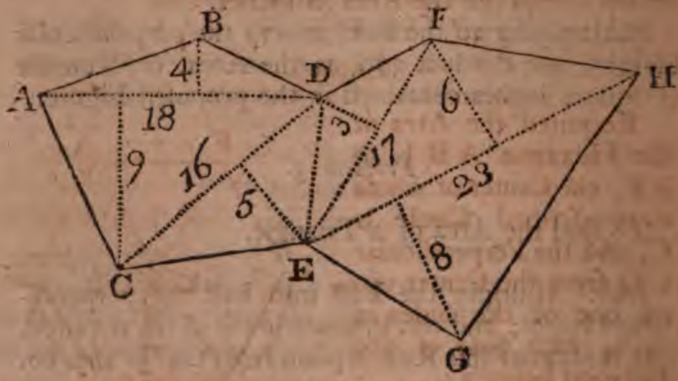
Problem 4.

To find the Area of any irregular Figure.

Rule. Reduce the Figure to Triangles, by drawing Diagonals therein; then find the Area of each Triangle, and the Sum of theſe is the Area of the propoſed Figure.

Example.

Required the Area of the irregular Figure ABDFHGEC.



Draw the Diagonals EH, EF, ED, DC, and DA, which will divide the Figure into ſix Triangles, in each of which let fall from any one of it's Angles a Perpendicular to the oppoſite Side; then ſuppoſing the Lengths of theſe to be as they are expreſſed in the Figure, the Operation will ſtand as follows:

2	into	18	is	36	The Area of the Triangle	A B D
4.5		18		81		A C D
2.5		16		40		C E D
1.5		17		25.5		E D F
3		23		69		E F H
4		23		92		E G H

343.5 the Area of the whole Fi-Figure.

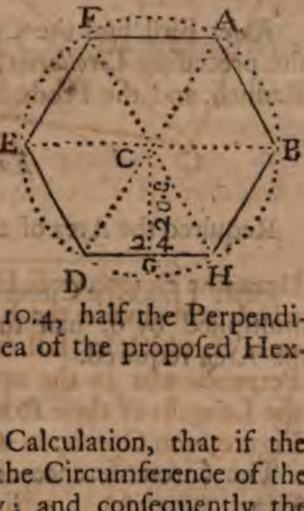
Problem 5.

To find the Area of any regular Polygon.

Rule. Through any three of the angular Points draw a Circle (by *Prob.* 8. *Sect.* I.) which will paſs through the reſt alſo; then from the Center of this Circle let fall upon any of the Sides a Perpendicular, and half this Perpendicular multiplied into the Sum of the Sides, will give the Area required.

Example.

Required the Area of the Hexagon A B H D E F, the Center of whoſe circumſcribed Circle is C, and the Perpendicular C G from the Center upon one of the Sides is 20.8, each Side of the Polygon being 24.



The Sum of the Sides is 144, which multiplied by 10.4, half the Perpendicular, gives 1497.6, the Area of the propoſed Hexagon.

2. It has been found by Calculation, that if the Diameter of a Circle be 1, the Circumference of the ſame will be 3.1416 nearly; and conſequently the Diameter of any Circle will be to it's Circumference as 1 to 3.1416, *&* *è contra.*

Cor. 1. Hence, multiplying the Diameter of any Circle by 3.1416, the Product will be the Circumference. Thus, let the Diameter of a Circle be 36; then 36 multiplied by 3.1416, will give 113.0976, the Circumference of the propoſed Circle.

Cor. 2. Hence, dividing the Circumference of a Circle by 3.1416, the Quotient will be the Diameter. So if the Circumference of a Circle be 75.3984, then this divided by 3.1416, will give 24, the Diameter of the propoſed Circle.

Now a Circle being a Polygon of an infinite Number of Sides, the Sum of all which is the Circumference, and the Perpendicular on any of them the Radius: Therefore

Problem 6.

Given the Diameter of a Circle, to find it's Area.

Rule. Firſt find the Circumference (by the firſt of the preceding *Corollaries*) which multiply by half the Radius, and the Product is the Area.

Example.

Required the Area of a Circle whoſe Diameter is 36.

Firſt, I find the Circumference is 113.0976, which multiplied by 9, half the Radius, gives 1017.8784, the Area required.

Problem 7.

The Circumference of a Circle given, to find it's Area.

Rule. Find the Diameter, by *Cor.* 2; then multiply the Circumference by half the Radius, and the Product is the Area.

Example.

Required the Area of a Circle, whoſe Circumference is 75.3984.

Firſt, I find the Diameter to be 24; then multiplying the Circumference 75.3984 by half the Radius, *viz.* 6, the Product 452.3904 is the Area required.

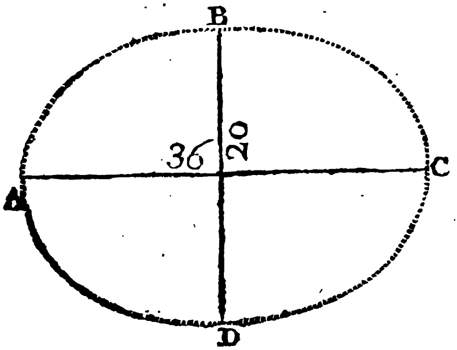
Problem 8.

To find the Area of an Ellipſe.

Rule. Multiply the greateſt Axis into the leaſt, and the Product into .7854, and this laſt Product is the Area.

Example.

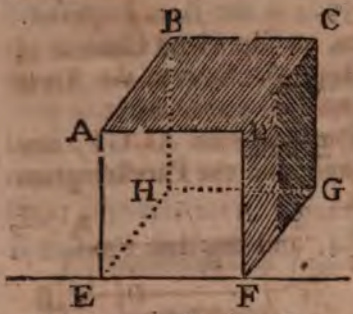
Suppoſe in the Ellipſe A B C D, the greateſt Axis



A C is 36, and the leaſt Axis B D 20; required the Area of that Ellipſe.

Multiplying 36 into 20, the Product is 720, which multiplied into .7854, gives 565.488, the Area of the propoſed Ellipſe.

3. A *Solid* is that which hath Length, Breadth, and Thickneſs.

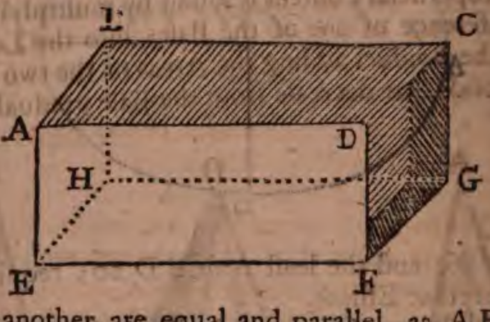


4. A *Cube* is a Solid bounded by ſix equal Squares. Thus the Solid ABCGFEHD, bounded by the ſix equal Squares ABCD, CDFG, ADFE, ABHE, BCGH, and HGFE, is a Cube.

If the terminating Squares be ſquare Inches, then the Solid is called a Cubic Inch; if ſquare Feet, a Cubic Foot, *&c.*

2. The Solidity of any Body in Inches, Feet, *&c.* is the Number of Cubic Inches, Feet, *&c.* the Body contains.

6. A *Parallelopiped* is a Solid terminated by ſix Quadrilateral Figures, of which each two oppoſite to one another are equal and parallel, as ABCG, FDHE.

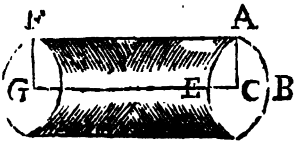


The Solidity of this Body is found by multiplying the Length, Breadth, and Thickneſs, into one another; and the Product is that required.

Example. Suppoſe in the *Parallelopiped* ABCDFGHE, the Length EF is 36 Feet, the Breadth DF 16, and the Thickneſs FG 12; then theſe three multiplied into one another will give 6912 for the Solidity, or Number of Cubic Feet the propoſed Body contains.

The Area of the Surface, or ſuperficial Content of that Body, is found by taking the Sum of the Areas of the Quadrilateral Figures that terminate it.

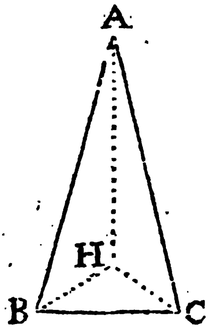
7. If in a rectangular Parallelogram ACGF, one of the Sides GC remain fixed, and the Parallelogram move quite round to it's firſt Place; then the generated Solid ADHF is called a Cylinder.

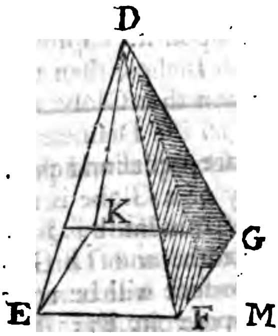


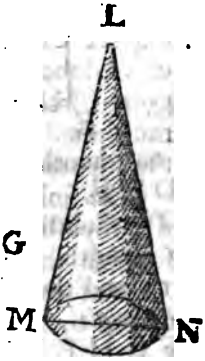
The Solidity of this Body is found by multiplying the Area of one of it's circular Baſes into the Length. Thus let the Radius AC of one of the Baſes of the *Cylinder* be 6 Inches, and the Length AF 36; then the Area of the Baſe ABDE will be 113.0976 (by *Problem* 6.) which multiplied into the Length 36, gives 4071.5136 for the Solidity.

The ſuperficial Content is found by multiplying the Circumference of one of the Baſes into the Length, and to the Product adding the Areas of the two Baſes.

8. Solids that decreaſe from the Baſe gradually 'till they end in a Point, are in general called *Pyramids*,







and are of different Kinds, according to the Figure of their Baſes. Thus a Pyramid, having a triangular Baſe, is called a *Triangular Pyramid*, as ABCH; and if the Baſe be a Parallelogram, it is called a *Parallelogramic Pyramid*, as DEFGK; and if a Circle, it is called a *Circular Pyramid*, or ſimply a *Cone*, as LMN, *&c.* The Point in which the Pyramid ends is called the *Vertex*; and a Line drawn from the Vertex perpendicular to the Baſe, is called the *Height* of the *Pyramid*.

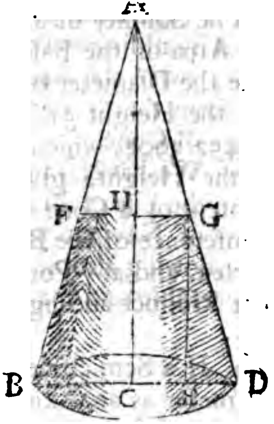
The Solidity of a *Pyramid* is found by multiplying the Area of the Baſe into $\frac{1}{3}$ the Height. Thus ſuppoſe the Diameter of the Baſe of a *Cone* is 24 Inches, and the Height 51; then the Area of the Baſe will be 452.3904, which multiplied by 17, the third Part of the Height, gives 7690.6368. The ſuperficial Content of a Cone is found by multiplying the Circumference of the Baſe into half the Line joining the Vertex, and any Point in that Circumference, and to that Product adding the Area of the Baſe.

9. If a Semicircle be turned quite round upon it's Diameter as an Axis, it will generate a Solid called a *Globe* or *Sphere*.

The Area of the Surface of a Globe is found, by multiplying the Diameter into the Circumference of a great Circle upon it. Thus ſuppoſe the Diameter of a Globe is 16 Inches, then the Circumference of a great Circle upon that Globe will be 50.2656, which multiplied by 16 the Diameter, gives 804.2496 for the ſuperficial Content in Inches.

The Solidity of a Globe is found, by multiplying the ſuperficial Content by $\frac{1}{6}$ the Diameter. Thus ſuppoſe the Diameter of a Globe is 18, then the Area of the Surface will be 1017.8784, which multiplied by 3 gives 3053.6352 for the Solidity.

10. We have ſhewn how to find the Solidity of a Cone, having the Diameter of the Baſe and the Height given, and thence we have a Method of finding the Solidity of a *Fruſtum* of a Cone, having the Diameter of each Baſe and the Height of the *Fruſtum* given. Let F B D G denote a Fruſtum of the Cone ABD, BD the greateſt, and FG the leaſt Diameter of the Fruſtum. Join the Vertex of the Cone A, and the Center of the Baſe C, with the right Line A C, which will paſs thro' H, the Center of the leaſt Baſe of the Fruſtum, and thro' G draw G E parallel to A C, which will be equal to H C, the Height of the Fruſtum; then 'tis evident that E D will be the Difference between the greateſt and leaſt Semi-diameters of the Fruſtum; and ſince the Triangles ACD and GED are ſimilar, therefore (by *Art.* 73. *Sect.* 1.) DE : DC :: EG : CA, *i. e.* As the Difference between the greateſt and leaſt Semi-diameters of the Fruſtum is to the greateſt Semi-diameter, ſo is the Height of the Fruſtum to the Height of the whole Cone. Conſequently, having the Diameter of the Baſe, and Height of the whole Cone, we can find it's Solidity; and from AC, the Height of the whole Cone, taking CH the Height of the Fruſtum, we have AH the Height of the Cone cut off, with which, and the Baſe FG, which is given, we may find the Solidity of the Cone cut off, A F G. Conſequently from the Solidity of the whole Cone A B D, taking the Solidity of the ſmall Cone A F G, there will remain the Solidity of the Fruſtum F B D G.



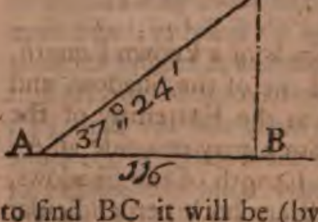
Example. Suppoſe the greateſt Diameter of the Fruſtum of a Cone is 20, and the leaſt 12, and the Height 12, then the Difference between the two Semi-diameters will be 4, and making it as 4 : 10 :: 12 : 30; we have 30 for the Height of the whole Cone, and from 30 taking 12, there remains 18, the Height of the leaſt Cone; ſo the Solidity of the whole Cone is 3141.6, and the Solidity of the leaſt Cone is 678.5856, the Difference of theſe is 2463.0144, which is the Solidity of the propoſed Fruſtum.

The ſuperficial Content of a Fruſtum of a Cone is found by adding to the ſuperficial Content of the whole Cone, twice the Area of the Baſe of the ſmall Cone, and from that Sum taking the ſuperficial Content of the ſmall Cone.

11. We have, in the preceding Part of this Book, ſhewn the Uſe of Plane Trigonometry in ſolving Problems of Navigation, and now we ſhall apply it, in the following Problems, to the meaſuring the Heights of acceſſible and inacceſſible Objects.

Problem 1.

To find the Height of any acceſſible Object.



Let BC be the Object to be obſerved, and from any Point A in the Level upon which the Object ſtands, let the Angle of Altitude CAB be obſerved, and meaſure the Diſtance AB; then in the right-angled Triangle ABC, are given the two oblique Angles A and C, and the Side AB, whence to find BC it will be (by *Caſe* 1. *of Rectangular Trigonometry*)

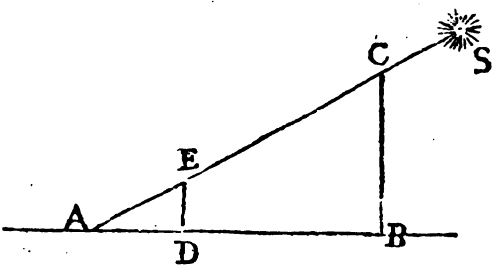
R : T, A :: AB : BC.

Example. Suppoſe the Angle of Altitude C A B is 37°, 24′, and the Length A B 116 Feet, then for B C it will be,

As Radius		10.00000
is to the Tang. of Altitude	37°, 24′	9.88341
ſo is A B	116	2.06446
to the Height of the Object B C	88.69	1.94787

Note, In taking the Height of any Object, if the Eye be not in the Level upon which the Object ſtands, then to or from the Height found, you muſt add or ſubtract the Diſtance of the Eye from the Level, according as it is placed above or below it, and the Sum, or Difference, is the true Height of the Object.

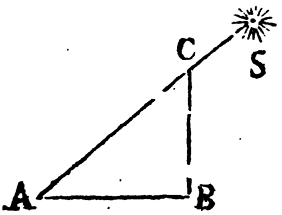
The Height of an acceſſible Object may alſo be found by means of it's Shadow. Thus ſuppoſe C B is the Object, and B A it's Shadow, cauſed by the Sun at S, and let D E be a Stick of a known Length, placed perpendicular to the Line of the Shadow, and in ſome Point of it D, ſo as the Extremity of the Shadows of the Object and Stick may coincide at A; meaſure A D and A B the Length of the Shadows, and then ſince E D and C B are both perpendicular to A B, it will be, as A D the Stick's Shadow, is to D E the Length of the Stick, ſo is A B the Object's Shadow, to C B the Height of the Object.



Problem 2.

To find the Altitude of the Sun by the Length of the Shadow of an acceſſible Object, whoſe Meaſure is alſo known.

Let C B repreſent a Stick, or any other acceſſible Object of a known Length, ſtanding perpendicular to the horizontal Plane AB, and let A B be it's Shadow made by the Sun at S; meaſure the Length of the Shadow A B, and then in the right-angled Triangle ABC are given the two Sides AB and BC, whence to find the Angle C A B, or the Altitude of the Sun at the Time of Obſervation, it will be (by *Caſe* 4. *of Rectangular Trigonometry*)



AB : BC : : R : T, A.

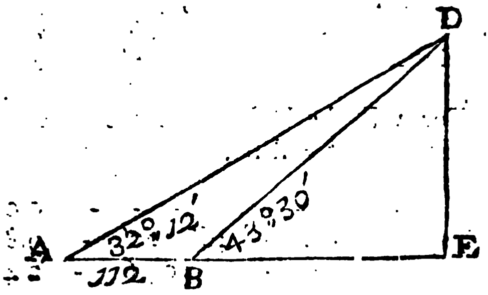
Example. Suppoſe the Stick B C is 4 Feet, and the Shadow of it A B 5, then for the Sun's Altitude it will be,

As the Length of the Shadow -	5 -	0.69897
is to the Length of the Stick -	4 -	0.60206
ſo is Radius - - - - - - - - - - -		10.00000
to the Tang. of the Sun's Alt.	38°, 39′ -	9.90309

Problem 3.

To find the Height and Diſtance of an inacceſſible Object.

Let D E repreſent an inacceſſible Object, and B a Point in the horizontal Plane on which it ſtands, and from whence we can obſerve the Angle of Altitude D B E; at any other Point in the ſame Plane as A, obſerve the Angle of Altitude D A E, and meaſure the Length of A B the Diſtance between the two Stations A and B, then in the Triangle A B D, having



the external Angle D B E, together with the internal oppoſite one A, we have the Angle ADB (by *Art.* 60. *Sect.* I.) and alſo the Side A B; whence for B D, the Hypothenuſe of the right-angled Triangle D E B, it will be (by *Caſe* 2. *of Oblique-angled Trigonometry*)

S, A DB : AB :: S, A : BD.

Then in the right-angled Triangle D E B, are given the Hypothenuſe B D, and the oblique Angles; whence for D E the Height of the Object, it will be (by *Caſe* 3. *of Rectangular Trigonometry*)

R, : S, DBE :: BD : DE.

And for B E, the Diſtance of the Object from the neareſt Station, it will be by the ſame,

R, : S, DBE :: BD : BE.

Example. Suppoſe the Angle of Altitude at B is 43°, 30', and at A 32°, 12', and the Diſtance A B between the two Stations is 112 Feet; then the Angle A D B will be 11°, 18', and the Angle B E will be 46°, 30'. Hence for B D it will be,

As the Sine of A D B - - -	11°, 18' -	9.29214
is to A B - - - - - - - -	112 - -	2.04922
ſo is the Sine of A - - - -	32°, 12' -	9.72663
to B D - - - - - - - - -	304.6 -	2.48371

Then for DE the Height of the Object, it will be,

As Radius - - - - - - - - - -		10.00000
is to the Sine of DBE -	43°, 30′ -	9.83781
ſo is BD - - - - - - -	304.6 -	2.48371
to DE - - - - - - - -	209.7 -	2.32152

Laſtly, For BE the Diſtance of the Object from the neareſt Station, it will be,

As Radius - - - - - - - - - -		10.00000
is to the Sine of BDE -	46°, 30′ -	9.86056
ſo is BD - - - - - - -	304.6 -	2 48371
to BE - - - - - - - -	221 - -	2.34427

If the Object ſtands upon a riſing Ground, then find the Height of the Object above the Plane on which you ſtand (*by the laſt Problem*) as alſo the Height of ſome Point on the riſing Ground near the Foot of the Object, and this laſt Height taken from the former will give the true Height of the Object.

SECT. XVI.

Of SURVEYING.

1. THE Inſtruments chiefly in uſe for taking Angles in the Field are, the *Plane-Table*, *Theodolite*, *Compaſs*, *Semicircle*, &c. the Nature and Uſe of which are much eaſier obtained by viewing the Inſtruments themſelves, than by a Deſcription of them from their Draughts upon Paper.

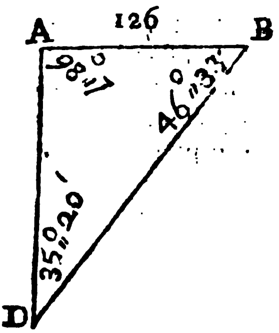
2. To meaſure Diſtances upon the Field, they commonly uſe Mr. *Gunter*'s Chain, which contains 22 Yards in Length, the 4th Part of which, 5½ Yards, or 16½ Feet, is called a *Perch*, or *Pole*, conſequently a ſquare

a ſquare Chain contains 16 ſquare Poles, and ſince an Acre contains 10 ſquare Chains, therefore 160 ſquare Poles is equal to one Acre. This Chain is commonly divided into 100 equal Parts called *Links*, and is ſometimes marked at every 10 Links, for the Conveniency of working by Decimals.

Problem 1.

To find the Diſtance of any Object from a given Point.

Let the Object be D, and the given Point A; then let the Diſtance between A and any other Point B (from whence we can ſee the Object) be meaſured, and with a Semicircle, or any other proper Inſtrument, take the Angles DAB and ABD; then in the Triangle ABD are given the Angles and the Side AB, whence to find the Side AD it will be (*by Caſe 2. of Oblique-angled Trigonometry*)



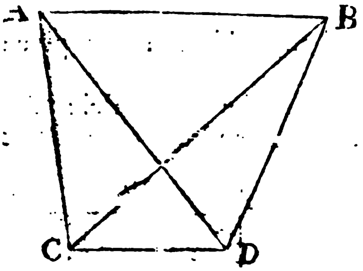
S, D : AB : : S, B : AD.

Example. Suppoſe BA is 126 Feet; the Angle A 98°, 07′, the Angle B 46°, 33′, and conſequently the Angle D 35°, 20′; then for AD it will be,

As the Sine of D - - -	35°, 20′ -	9.76218
is to the Diſtance AB - -	126 - -	2.10037
ſo is the Sine of B - - - -	46°, 33′ -	9.86092
to the Diſt. between A and D -	158.2 -	2.19911

Problem 2.

To find the Diſtance between two inacceſſible Objects.



Let the two Objects be A and B, to which we cannot approach, being hindered by a River, *&c.* aſſume in ſome convenient Place two Points C and D, from each of which you can ſee the two Objects, and meaſure the Diſtance between them; then at the Point C obſerve the Angles ACD and DCB, and at D obſerve the Angles CDB and CDA; ſo in the Triangle CDB are given the two Angles BCD and CDB (and conſequently the Angle CBD) and the Side CD; whence to find CB it will be, S, CBD : S, CDB :: CD : CB. Again, in the Triangle ACD are given the two Angles ACD and ADC (and conſequently the Angle CAD) and the Side CD, whence to find AC it will be, S, CAD : S, CDA :: CD : CA. Laſtly, from the Angle ACD take the Angle DCB, and there will remain the Angle ACB; then in the Triangle ACB are given the two Sides AC and CB, and the included Angle ACB, whence AB, the Diſtance between the two Objects is found by *Caſe* 5. *of Oblique Trigonometry*.

Example. Suppoſe the Angle ACD is 94°, 55′, the Angle BCD 41°, 25′, the Angle CDB 103°, 14′, the Angle ADC 46°, 44′, and the Side CD 144 Feet? Then 1ſt for CB it will be,

As the Sine of CBD	35°, 21′	9.76236
is to the Sine of CDB	103°, 14′	9.98831
ſo is CD	144	2.15836
to CB	242.3	2.38431

2dly, for CA it will be,

As the Sine of CAD	38°, 21′	9.79256
is to the Sine of CDA	46, 44	9.86223
ſo is CD	144	2.15836
to CA	169.1	2.22803

Laſtly, for AB it will be,

As the Sum of the Sides AC and CB	411.4	2.61426
is to their Difference	73.2	1.86451
ſo is the Tang. of ½ the Sum of the Ang. CAB and CBA	63°, 15′	10.29753
to the Tang. of ½ their Diff.	19, 26	9.54778

Then,

As the Sine of CBA	43°, 49′	9.84033
is to the Sine of ACB	53, 30	9.90518
ſo is AC	169.1	2.22803
to AB	196.3	2.29288

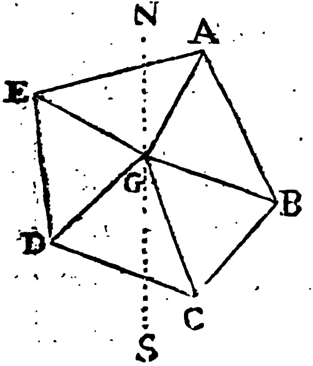
conſequently the Diſtance between the two Objects A and B is 196.3 Feet.

Problem 3.

To take the Plot of a Field at one Station, in or near the Middle of it, when we can from thence ſee all the Angles or Corners of the Field.

This may either be done by the *Plane-Table* or *Theodolite*, or any of the other Inſtruments abovementioned.

Let ABCDE repreſent the Field; and firſt ſuppoſe you are to plot it with the Plane-Table: Having planted the Table with a Sheet of white Paper, fixed upon it, in or near the Middle of the Field, as at G, mark a Point upon the Paper, to repreſent the Point of the Field on which the Table ſtands, and laying the Edge of your Index upon that Point, and keeping it there, turn it about ſo as you can through the Sights ſee one of the Angles, as A; then from the Point, along the Edge of the Index, draw the Line G A, and meaſuring the Diſtance on the Field, from the Plane-Table to the Angle at A, in Chains and Links, take it from any convenient Line of equal Parts, and ſet it off upon the Paper, from G to A along the Line GA; then (keeping the Table ſtill fixed as it was) turn the Index ſo, as it lying with it's Edge upon the Point G, you may thro' the Sights ſee the Angle B, and drawing the Line G B, meaſure the Diſtance G B in the Field, which ſet off upon the Table from G to B; after the ſame Manner drawing the Lines G C, G D, and G E, and joining the Extremities of them with the right Lines A B, BC, C D, D E, and E A, the Field is protracted, and the Lines B A, A E, &c. taken from the Scale from which you protract the reſt, will give the Lengths of them in the Field.



To perform the ſame with the Theodolite, place the Inſtrument in or near the Middle of the Field, as at G, and ſo as the Needle may hang directly over the Meridian Line of the Card, which let N S repreſent; then direct your Sights from G to the

Angle A, and obſerve the Number of Degrees it cuts, or the Bearing of A, which ſuppoſe to be N 16°, 24′ E, and place this in the Field-Book, together with the Diſtance in Chains and Links from G to A, and proceeding the ſame Way with the reſt of the Angles, you will have the Bearing of each Angle from the Meridian, together with the Diſtance of each from the Inſtrument, in your Field-Book, the Form of which follows:

The FIELD-BOOK.

Angles.	Bearings.	Chains.	Links.	Remarks.
A	N 16, 24 E	7	20	
B	S 73, 35 E	7	60	
C	S 19, 15 E	7	65	
D	S 54, 56 W	6	65	
E	N 59, 40 W	7	26	

The Table is ruled into five Columns; in the firſt are marked down the Angles expreſſed by Letters, or any other Characters at pleaſure; the ſecond contains the Bearing of theſe Angles from the Meridian; the third and fourth their Diſtances in Chains and Links from the Place of Obſervation, and the fifth is for any remarkable Occurrence.

Having marked down the Bearings of all the Angles in the Field from the Meridian, together with their Diſtances in Chains from the Place of Obſervation, in your Field-Book, you may afterwards protract it upon Paper in the following Manner, *viz.* Aſſume any convenient Point in the Paper to repreſent the Place of Obſervation, and through it draw a Line repreſenting the Meridian; then from that Point draw Lines making Angles with the Meridian, as in the Field-Book, and ſet off from the ſaid Point upon theſe Lines the ſeveral Diſtances expreſſed in the Field-Book, taken from any Scale of equal Parts. Laſtly, joining the Extremities of them with right Lines, the Field will be protracted, and the Area of it in Chains may be found by *Prob.* 4. *Sect.* XV. which divided by 10 will give the Area in Acres.

The Method of plotting a Field by the *Semicircle*, *Circumferentor*, &c. differs ſo little from the Way of doing the ſame by the Theodolite, that it would be altogether needleſs to ſhow it in each of them. When the Angles of the Field are at ſuch a Diſtance from you, that you cannot perfectly perceive them from your Station, then put Marks of white Paper, or Pieces of Linen, at each of them, ſo as you may eaſily ſee them.

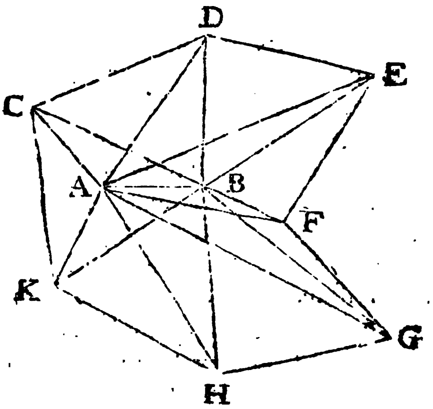
If it be more convenient to plot the Field at one Station, in or near ſome Corner of the Field, then you are to do it the ſame Way by the Plane-Table, Theodolite, or any other of the Inſtruments, as when your Station was in or near the Middle of the Field.

Problem 4.

To plot a Field at two Stations near the Middle thereof, the Diſtance between which Stations is known, and from each of which all the Angles in the Field can be eaſily ſeen.

Let the Field to be plotted be C D E F G H K, in which chuſe two convenient Points A and B near the Middle, from each of which you can perceive all the Angles, and the Diſtance between which you know; then if you are to plot it by the *Plane-Table*, plant the Table upon the Point A, and mark a certain

Point upon the Table to repreſent it, upon which lay the Edge of the Index, and direct the Sights to the other Station B, and by the Side of the Index draw A B, then from A along that Line ſet off a Line AB, taken from any convenient Scale of equal Parts, equal to the Diſtance between your two Stations; then laying the Edge of your Index upon the



Point A, and directing your Sights to D, draw the Line A D; the ſame Way keeping the Edge of the Index on A, direct the Sights to all the other Angles of the Field ſucceſſively, and draw the Lines A E, A F, &c. then remove the Table to the other Station B, and laying the Edge of the Index along the Line A B, turn the Table about 'till you can thro' the Sights ſee the other Station A, and fixing the Table, lay the Edge of the Index on B, and direct the Sights to D, and draw the Line B D, which will interſect A D in D; the ſame Way keeping the Edge of the Index ſtill on the Point B, direct the Sights to all the other Angles of the Field, and draw the Lines B E, B F, &c. which will interſect the former Lines drawn from A in the Points E, F, G, *&c.* and joining theſe Points with right Lines, you'll have the Plot of the Field, and the Lines D E, E F, *&c.* taken from the ſame Scale of equal Parts that A B was taken from, will give the Diſtances of the Angles in the Field from one another. Laſtly, the Area of the Field being thus protracted, may be found by *Prob.* 4. *of the laſt Section.*

In plotting of a Field at two Stations, you ought to take the Stations as far aſunder as conveniently you can; for the nearer they are together, the more Danger there is of contracting an Error, *& è contra.*

To plot the ſame by the Theodolite: Having fixed the Inſtrument in one of the Stations, as A, turn it about 'till the Needle be directly over the Meridian Line of the Card; then turn about the Index 'till you can through the Sights ſee the other Station B, and obſerve the Bearing of it from the Meridian, and meaſure the Diſtance in Chains and Links, both which ſet down at the Head of the Field-Book, thus:

A B S 75°, 23′ E——3 Chains 24 Links.

Then turn the Index to the Angle D, and obſerve it's Bearing from the Meridian, and the ſame Way turning the Index to all the Angles of the Field, obſerve the Bearing of each of them, which ſet down in the Field-Book in the ſecond Column, marked at the Top thus, *Station* A. Then go to the Station B, and fixing your Inſtrument as before, turn the Sights to the Angle D, and obſerve the Bearing of it from the Meridian, and the ſame Way turning the Sights to the reſt of the Angles, obſerve the Bearing of each of them, which mark down in another Column of your Field-Book, marked at the Top with *Station* B, and your Work in the Field is finiſhed; the plotting of which upon Paper is ſo plain and eaſy, that it needs no Example.

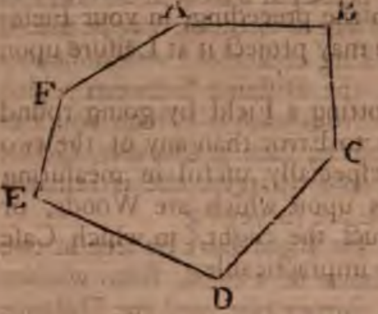
By this Method the principal Places in a Survey of a County, or any large Piece of Ground, may be placed in a Map, *viz.* by making choice of two Eminences for your two Stations, the Diſtance between which you can meaſure, and from each of which you can ſee all the principal Objects, ſuch as *Churches*, *Caſtles*, *Hills*, *Gentlemens Seats*, and whatever elſe is remarkable in the Ground you are ſurveying.

If all the Angles of the Field can't be ſeen at two Stations, then make choice of a third, from whence you can ſee any of the former two, and the Diſtance between which you can meaſure; and if that be not ſufficient, then uſe a fourth, fifth, *&c.* Station; by which Means you will always have two Stations to proceed with through the County you are to ſurvey, be it ever ſo large; and even in a Field, where you can take the Survey of it at two Stations alone, the chuſing a third Station from whence you can ſee one of the former ones, and alſo all the Angles of the Field, and thence taking the Plot of it as before, is a ſure Way of proving your former Work.

Problem 5.

To plot a Field by going round it.

Let the Field be ABCDEF, and ſuppoſe you are to plot it by the Plane-Table: Having fixed your Inſtrument at any of the Angles of the Field as A, mark a Point upon the Paper to repreſent it; then laying the Edge of the Index upon A, turn it about 'till through the Sights you can ſee the adjacent Angle F, and along the Edge of the Index draw the Line AF, which meaſure in the Field, and taking that from any Scale of equal Parts, ſet it off upon the Line AF on the Table from A to F; then move your Table from A to F in the Field, and fix it ſo as the Edge of the Index, lying on the Line FA, you can thro' the Sights ſee the Angle A, and laying the Edge of the Index on F, turn it about 'till through the Sights you can ſee E, and draw the Line FE, which meaſure in the Field, and taking it from the ſame Scale, ſet it off upon the Table from F to E: After the ſame Manner proceeding with the reſt of the Angles, you will have the Plot of the Field.



To plot the ſame by the Theodolite. Having placed your Inſtrument at the Corner of the Field you are to begin from, as at A, ſet the Index at 00 Deg. 00 Min. then turn the Inſtrument about, with that End of the Index forward (or towards F) that lies upon 00 Deg. 00 Min. 'till you can through the Sights ſee the Angle F; and there fixing the Inſtrument, turn the Index about 'till you can through the Sights ſee the Corner B, and mark the Degrees (in your Field-Book) cut by the Index, which will be the Meaſure of the Angle F A B, and meaſure A F, in Chains and Links, which alſo mark down in your Field-Book; then remove your Inſtrument to F, and placing the Index upon the Beginning of the Degrees as before, turn the Inſtrument about 'till you can thro' the Sights ſee the Corner A, and fixing the Inſtrument there, turn the Index about 'till you ſee thro' the Sights the Corner E, and mark the Degrees cut by the Index in your Field-Book, which will be the Angle AFE, then meaſure FE in Chains and Links, which alſo mark down in your Field-Book; the ſame Way proceeding with the reſt of the

Angles, mark down the Quantity of each, together with the Diſtance from the preceding, in your Field-Book; and thence you may project it at Leiſure upon Paper.

This Method of plotting a Field by going round it, is much leſs liable to Error than any of the two former, and is more eſpecially uſeful in meaſuring large Fields, or Fields upon which are Woods, or other Things to obſtruct the Sight, in which Caſe the other Methods are impracticable.

SECT. XVII.

Of GAUGING.

1. WE have ſhewn in Sect. XV. how to find the Solidity of ſeveral Sorts of Bodies, in Inches or Feet, &c. which Solidity (if taken in Inches) divided by the Inches contained in a Gallon, Buſhel, &c. will ſhew the Number of Gallons, Buſhels, &c. contained in the Veſſel.

The Number of ſolid Inches contained in a Gallon, Buſhel, &c. as determined by Act of Parliament, is as follows:

A Gallon of Ale or Beer	contains	282	Cubic Inches
of Wine		231	
of Corn		268.8	
A Buſhel of Malt		2150.4	
of Coals		2246	
A Scots Pint		102.3	

2. In Gauging, the Veſſels that are not cylindrical are commonly reduced to Cylinders, and their Solidities found as ſuch.

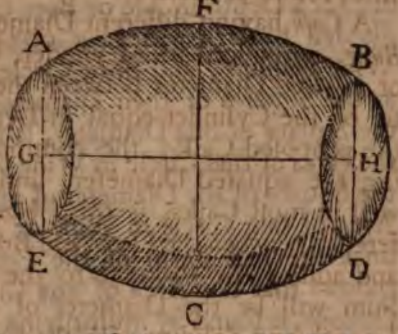
A *Caſk* having different Diameters at the *Head* and *Bung*, is reduced to a Cylinder, by taking the mean or equated Diameter between the two for the Diameter of the Cylinder equal in Length and Solidity to the propoſed Caſk; the common Method for finding the equated Diameter, and which ſerves pretty well in moſt Caſks, is this, *viz.* Multiply the Difference between the Head and Bung-diameters by .65, and adding the Product to the Head-diameter, the Sum will be the Diameter of a Cylinder of equal Length and Solidity with the Caſk.

Hence we have the following Rule for finding the Content of any Caſk in *Wine*, *Beer*, &c. the Head and Bung-diameter, and Length of the Caſk being given in Inches; *viz.* Find the equated Diameter between the Head and Bung-diameters of the Caſk, and thence find the Area of the Circle belonging to that Diameter; then multiply this Area by the Length of the Caſk, and the Product will be the Solidity of the Caſk in Inches, which divided by the ſolid Inches contained in a Gallon of Wine, Beer, *&c.* will give the Content of the Caſk in Wine, Beer, *&c.*

Example.

Let it be required to find the Content of the Caſk A E D B in Wine Gallons, whoſe Head-diameter A E or B D is 26 Inches, the Bung-diameter F C 34 Inches, and the Length G H 55 Inches.

The Difference between the Head and Bung-diameters is 8, which multiplied by .65, gives 5.2, and this added to 26, the Head-diameter, makes 31.2 for the equated Diameter, or Diameter of the Cylinder equal in Length and Solidity with the propoſed Caſk, the Area of whoſe Baſe is 764.539776, which multiplied into 55 the Length, gives 42049.68768 for the Solidity in Inches; and this divided by 231, the ſolid Inches contained in a Gallon of Wine, gives 182.03328 for the Content of the propoſed Caſk in Wine Gallons.



3. If the propoſed Caſk be ſtanding with it's Axis perpendicular to the Horizon, and is not quite full of Liquor, then in order to find the Contents of the contained Liquor, you muſt find the equated Diameter, as above, and thence the Area of the Baſe of the Cylinder, the Caſk is reduced to; which multiplied into the Depth of the Liquor, will give the ſolid Content of the contained Liquor in Inches, and this divided by the Inches in a Gallon of Wine, Beer, *&c.* according to the Liquor contained, will give the Contents of the Liquor in the Caſk.

This Rule more eſpecially ſerves when the Caſk is more than half full of Liquor; but when it is leſs than half full, then the Content of the contained Liquor is better found by ſubtracting the Content of the empty Part of the Caſk (found as above) from the Content of the whole, and the Remainder will be the Content of the contained Liquor.

4. In Gauging, by the Area of any Surface in Wine, *&c.* Gallons, is meant the Content of it at one Inch Depth: Conſequently the Area of a Circle one Inch Diameter being .7854, this divided by

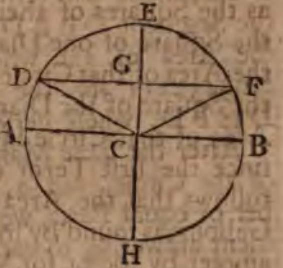
282, will give .002785 for the Content of that Circle one Inch Depth in Ale or Beer Gallons, and the ſame divided by 231 will give .0034 for it's Content in Wine Gallons; and ſince Circles are to one another as the Squares of their Diameters; therefore, As 1, the Square of one Diameter, is to .0034 or .002785, the Area of that Circle in Wine or Ale Gallons; So is the Square of the Diameter of any other Circle, to the Area of that Circle in Wine or Ale Gallons: Hence ſince the firſt Term of the Proportion is Unity, it follows that the Area of any Circle in Wine or Ale Gallons, is found by multiplying the Square of the Diameter by .0034 for Wine Gallons, and by .002785 for Ale Gallons, and this Area multiplied into the Length of the Caſk to which the Circle belongs, will give the Content of the Caſk in Wine or Ale Gallons; and hence the two Numbers .0034 and .002785 are called *Fixt Multipliers.*

Again, If 1 be divided by the former Numbers .0034 and .002785, there will be produced their Reciprocals 294.12, and 359, with the firſt of which, dividing the Square of the Diameter of any Circle, the Quotient will be the Area of that Circle in Wine Gallons; and if the ſame be divided by the laſt, the Quotient will be the Area of that Circle in Ale Gallons; hence theſe two Numbers 294.12 and 359 are called *Fixt Diviſors*, and in Practice are commonly made uſe of by Gaugers.

5. When a *Caſk* is lying upon it's Side, with the Axis parallel to the *Horizon*, and is not full, but the Surface of the contained Liquor cuts the Heads of the Caſk, then to find the Contents of the Liquor contained in the Caſk, we muſt firſt know how to find the Area of any Segment of a given Circle: In order to which,

Let AEBH repreſent a Circle, whoſe Diameter AB is 2; then (*by Cor.* 1. *Art.* 2. *Sect.* XV.) the Circumference of that Circle will be 6.2832, and the

Area 3.1416 (by *Prob.* 6. *Sect.* XV.) Hence 'tis evident, that if the Diameter of a Circle be two Inches or Feet, *&c.* the Circumference of that Circle will contain twice as many Inches or Feet, *&c.* in Length, as the Area of it contains ſquare Inches or Feet, *&c.* i. e. the Length of the Circumference is double the Area; and ſince the Area of the whole Circle, is to the Area of any Sector of it, as the Length of the whole Circumference, to the Length of the Arch of that Sector; it follows, that the Length of half the Arch of any Sector of a Circle whoſe Diameter is 2, is equal to the Area of that Sector. So in the annexed Scheme the Length of D E, half the Arch of the Sector D C F E will be the Area of that Sector.



In the annexed Scheme, ſuppoſe G E (the verſed Sine of half the Arch of the Sector D C F E) to be equal to .4; then ſince the Radius C E is 1, 'tis evident C G (the right Sine of D A, the Complement of D E half the Arch of the Sector) will be equal to .6; ſo making it as 1 is to .6, or (to avoid Fractions) as 100 is to 60, ſo is the Radius of the Tables to a fourth Number; this will be the Sine of A D, and looking into the Table, we ſhall find it anſwer to 36.87 Degrees; the Complement of which, *viz.* 53.13 Degrees, is the Arch D E; which multiplied by .017453, the $\frac{1}{360}$ of 6.2832, gives .92727789 for the Length of the Arch D E, which is equal to the Area of the Sector D E F C.

Again, In the right-angled Triangle C G D, 'tis evident (by *Cor.* 1. *Art.* 70. *Sect.* I.) if from 1, the Square of C D, we take .36, the Square of C G, there will remain .64, the Square of D G, the Square Root of which, *viz.* .8, is equal to D G, and this doubled gives 1.6, equal to DF, which multiplied into .3, the half of CG, produces 48 for the Area of the Triangle DCF. Then from .92727789, for the Area of the Sector DCFE, taking .48, the Area of the Triangle DCF, there will remain .44727789 for the Area of the Segment DEFD; and this taken from 3.1416, the Area of the whole Circle, there will remain 2.69432211 for the Area of the other Segment DHFD, whoſe verſed Sine is 1.6.

After the ſame Manner, by dividing the Diameter of the Circle, *viz.* 2, into 100, or any other Number of equal Parts, we may find the Area of the Segment anſwering to each verſed Sine.

Having by the foregoing Method found the Area of a Segment belonging to any verſed Sine in that Circle, whoſe Diameter is 2, and Area 3.1416, we may find the Area of the ſimilar Segment in any other Circle by the following Analogy, *viz.*

As the Area of that Circle whoſe Diameter is 2, *viz.* 3.1416, is to the Segment belonging to any Part of it's Diameter, So is the Area of any other Circle to the Segment belonging to the like Part of it's Diameter.

And hence ariſes the Conſtruction of the following Table.

A TABLE of the Segments of a Circle, whoſe Area is 1 the Diameter, viz. 1.128378, being divided into 100 equal Parts.

V.	Segm.	V.	Segm.	V.	Segm.	V.	Segm.	V.	Segm.
1	,0017	21	,1526	41	,3860	61	,6389	81	,8677
2	,0048	22	,1631	42	,3986	62	,6514	82	,8776
3	,0087	23	,1738	43	,4112	63	,6636	83	,8873
4	,0134	24	,1845	44	,4238	64	,6759	84	,8968
5	,0187	25	,1955	45	,4365	65	,6881	85	,9059
6	,0245	26	,2066	46	,4491	66	,7002	86	,9149
7	,0308	27	,2178	47	,4618	67	,7122	87	,9236
8	,0375	28	,2292	48	,4745	68	,7141	88	,9320
9	,0446	29	,2407	49	,4873	69	,7360	89	,9402
10	,0520	30	,2523	50	,5000	70	,7477	90	,9480
11	,0598	31	,2640	51	,5127	71	,7593	91	,9554
12	,0680	32	,2759	52	,5255	72	,7708	92	,9625
13	,0764	33	,2878	53	,5382	73	,7822	93	,9692
14	,0851	34	,2998	54	,5509	74	,7934	94	,9755
15	,0941	35	,3119	55	,5635	75	,8045	95	,9813
16	,1032	36	,3241	56	,5762	76	,8155	96	,9866
17	,1127	37	,3364	57	,5888	77	,8262	97	,9913
18	,1224	38	,3486	58	,6014	78	,8369	98	,9952
19	,1323	39	,3611	59	,6140	79	,8474	99	,9983
20	,1424	40	,3735	60	,6265	80	,8576	100	1,0000

In this Table you may obſerve, that the Columns marked at the Top with V, contain the verſed Sines, proceeding from 1 to 100, and the adjacent Columns contain the Areas of the Segments belonging to theſe verſed Sines.

By this Table the Content of the Liquor contained in a Caſk not full, lying with it's Axis parallel to the Horizon, and the contained Liquor cutting the Heads of the Caſk, may be found after the following Manner, *viz.*

To the wet Inches of the Bung-diameter, add a competent Number of Cyphers, and divide this by the whole Diameter; then ſeek for the Quotient in the Columns marked V at the Top in the preceding Table, and oppoſite to this in the adjacent Column, you'll find the Area of a Segment, which multiply into the whole Content of the Caſk, and the Product is the Content of the Liquor in the Caſk. If inſtead of the wet Inches we had uſed the dry, then the laſt Product would have been the Content of the empty Part of the Caſk, which is called the *Ullage*.

Example.

Suppoſe a Caſk lying with it's Axis parallel to the Horizon, has a certain Quantity of Wine in it, the Bung-diameter is 32 Inches, the Head-diameter 28, the Length 48, and the wet Inches 20; required the Content of the Liquor.

To the wet Inches 20, I add a Number of Cyphers, and dividing it by 32, I find the Quotient .66, which I look for in the Table, and find it anſwer to the Segment .7002, which multiplied by 152.8, the whole Content of the Caſk in Wine Gallons (found by *Art.* 2. of this *Sect.*) gives 107 for the Content of the Liquor in the Caſk, in Wine Gallons.

6. Malt when lying on a Floor, is gauged by taking the Depth of it in Inches, in ſeveral Places, and dividing the Sum of theſe Depths by the Number of them, the Quotient will be the mean Depth; which multiplied into the Area of the Surface gives the Content in Inches; and this divided by 2150.4, gives the Content in Buſhels.

7. Solid Timber is meaſured by the ſolid Foot, each containing 1728 Cubic Inches; the common Way is this, *viz.* girth the Tree in ſeveral Places, and take $\frac{1}{4}$ of the mean Girth in Inches, for the Side of a Square; which Square multiply into the

Length of the Tree, and the Product will be the Solidity in Inches, and this divided by 1728, will give the Solidity of the Tree in Feet.

8. The Solidity of irregular Bodies may be found exactly, after the following Method, *viz.* Let the Body be immerſed in Water in a Paralleliped, whoſe Sides are exactly divided into Inches, and the Solidity of the Water raiſed will be equal to the Solidity of the immerſed Body.

9. The common Rule for finding the Tunnage of a Ship is as follows:

Multiply the Length of the Keel by the Breadth, and the Product by half the Breadth; then divide this laſt Product by 95, and the Quotient will give the Tunnage.

Example.

Suppoſe a Ship's Keel is 135 Feet, and her Breadth, from out to out, 48 Feet; required the Tunnage of that Ship.

The Length of the Keel, *viz.* 135, multiplied into the Breadth 48, produces 6480, and this multiplied into 24, half the Breadth, gives 155520, which laſt divided by 95, the Quotient is 1637, the Tunnage of the propoſed Ship,

A TABLE

A TABLE *of the Latitudes and Longitudes of ſome of the moſt principal Harbours, Headlands, and Iſlands, in the moſt frequented Parts of the World, the Longitude being counted from the Meridian of* LONDON.

Places Names.	Lat.			Long.		Den.
The Coaſt of *England.*	D.	M.		D.	M.	
BERWICK	55	50		01	39	W
Newcaſtle	54	51		01	30	W
Scarborough	54	20		01	20	W
Stockton	54	33		01	25	W
Flamborough-head	54	08		01	11	E
Yarmouth	52	45		01	40	E
Ipſwich	52	14		01	00	E
Colcheſter	52	04		00	58	E
LONDON	51	32		00	00	
The *Downs*	51	25	Latitude North	01	21	E
Dover	51	15		01	18	E
Beachy	50	48		01	25	W
Portſmouth	50	48		01	00	W
Dartmouth	50	27		03	36	W
Plymouth	50	36		04	13	W
Lizard	50	00		05	14	W
Briſtol	51	32		02	35	W
Liverpool	53	20		03	10	W
Whitehaven	54	10		03	50	W
The Coaſt of *Scotland.*						
Glaſgow	55	53		04	05	W
Aberdeen	57	24		01	37	W
Leith	56	00		02	55	W
St. Kilda	58	02		01	05	W
Cat-Neſs	58	47		02	06	W
Buchan-Neſs	57	55		01	20	W
Orkney Iſles	59	13		03	32	W

Places Names.	Lat.		Long.		Denom.
	D.	M.	D.	M.	
Coaſt of *Ireland*.					
Londonderry	55	05	08	00	W
Belfaſt	54	36	06	50	W
Cork	51	45	08	00	W
Cape Clear	51	10	10	30	W
Lambay	53	24	07	30	W
Dublin	53	12	06	55	W
Coaſt of *Holland* and *Flanders*					
Hamburgh	53	41	10	25	E
Bremen	53	50	08	00	E
The *Texel*	53	10	04	59	E
Amſterdam	52	21	04	51	E
Rotterdam	51	55	04	21	E
Dunkirk	51	14	02	20	E
Calais	50	57	01	55	E
On the Coaſt of *France* and *Portugal.*					
Guernſey	49	36	02	40	W
Jerſey	49	20	02	19	W
Rochelle	46	10	01	14	W
Bourdeaux	44	55	00	45	W
Bilboa	43	30	03	00	W
Porta Port	40	52	07	50	W
Cadiz	36	20	06	28	W
Coaſt on the main Continent within the *Straits*, and on the Coaſt of *Spain*, &c.					
Gibraltar	36	11	05	20	W
Malaga	36	50	03	17	W
Barcelona	41	26	02	26	E
Marſeilles	43	20	05	27	E
Toulon	43	06	05	40	E

Latitude North.

Places Names.	Lat.			Long.		Den.
	D.	M.		D.	M.	
Genoa — — —	44	27	North Latitude.	09	06	E
Leghorn — — —	43	18		10	44	E
Rome — — —	41	51		13	05	E
Naples — —	41	25		15	40	E
Gallipoli — —	40	08		18	42	E
Venice — — —	45	18		12	40	E
Conſtantinople — —	41	07		31	45	E
Smyrna — — —	38	28		27	20	E
Scanderoon — —	36	00		35	58	E
Tripoli — — —	34	40		35	48	E
Alexandria — —	31	07		33	00	E
Algier — — —	36	40		03	05	E
Coaſt of *Barbary* and *Guinea*, &c.						
Sallee — — —	33	43		06	30	W
Cape de Verde — —	14	30		16	26	W
River *Gambia* — —	13	16		15	20	W
Monſerado — —	06	05		09	20	W
Cape Corce — —	04	40		03	10	E
Cape Formoſa — —	04	40		08	00	E
River *Congo* — —	05	45	S. Lat.	15	27	E
Angola — — —	01	51		15	56	E
Cape St. Thomas — —	23	10		14	23	E
Cape of Good Hope — —	34	15		17	00	E
Weſtern Iſlands.						
Corvo — — —	40	05	North Lat.	31	55	W
Fyal — — —	39	32		31	52	W
Pico — — —	38	45		28	34	W
Griatioſa — —	39	30		28	15	W
St. Michael — —	37	50		24	52	W
St. Marys — —	37	00		22	17	W
Porto Sancto — —	32	45		16	05	W
Madeira, Weſt End —	32	20		17	30	W

Places Names.	Lat. D.	Lat. M.		Long. D.	Long. M.	Den.
Teneriff	27	60		17	05	
Canary	27	40		16	10	
St. Antonio	17	20		24	50	
Fuego	15	00		24	05	
Jago	15	10		23	30	
St. Lucia	17	20		24	00	
St. Nicholas	17	12		23	30	
St. Vincent	17	10		24	20	
Antegoa	17	30		60	40	
Barbadoes	13	30		58	10	
Berbuda	17	58		60	40	
St. Cruz	18	00		63	25	
Coaſt of *Carolina*, *Virginia*, *Maryland*, &c.			North Latitude.			Weſt Longitude.
Charles Town on *Aſhley River*	32	40		78	50	
Cape Henry	37	00		74	25	
Quebeck	47	15		68	10	
New York	41	00		72	05	
Boſton	42	35		68	50	
Trinity Bay	48	27		52	15	
Cape St. Mary	47	10		53	20	
Placentia	47	57		53	00	
Cape Charles	37	14		74	15	
St. John's Harbour.	47	28		51	23	
Coaſt of *Hudſon's-Bay* and the *Straits.*						
Cape Jones	55	03		78	56	
Albany River	51	16		79	44	
Shark Point	64	27		83	16	
Button's Iſle	60	05		66	50	
Cape Charles	62	35		74	36	
Port Nelſon	67	10		92	50	

Places Names.	Lat.			Long.		Den.
	D.	M.		D.	M.	
Coaſt of *America* in the *South Sea.*						
Cape St. Sebaſtian	42	40	N. Lat.	129	40	Weſt Longitude.
Panama	08	56		82	18	
Aquapulco	15	27		101	03	
Cape St. Lucia	23	25		111	56	
Cape del Ajugo	16	38	South Latitude.	88	50	
Arica	18	12		74	07	
Baldivia	39	35		81	18	
Cape Victory	52	15		82	56	
Cape Horn	57	58		79	44	
Coaſt of *Brazil* in *S. America*						
River *Julian*	48	40		74	32	
Cape Blanco	46	50		72	05	
St. Katherine's Iſle	28	00		47	50	
Cape Frio	23	10		42	56	
Cape Roque	05	00		35	52	
Coaſt on the main Continent in the *Weſt Indies.*						
North Cape	02	05	North Latitude.	49	55	
Surinam	06	00		56	44	
Carthagena	10	50		75	50	
Campeachy	19	20		93	05	
Porto Bello	09	55		80	15	
La Vera Cruz	19	15		100	22	
Cape Florida	24	48		81	55	
Southern Iſlands.						
Aſcenſion	07	40	S	14	50	
St. Helena	16	06	S	06	30	
St. Matthew's	01	40	S	07	50	
Princeps	01	35	N	09	03	E
St. Thomas	00	00		08	00	E
Annabona	01	05	S	07	30	E.

Places Names.	Lat.			Long.		Den.
Coaſt of the *Eaſt Indies.*	D.	M.		D.	M.	
Moſambique — —	15	05	S. Lat.	40	30	
River *de Fugos* — —	00	00		41	15	
Cape de Baſſus — —	04	00	North Latitude.	44	50	
Surat — — —	21	08		73	25	
Siam Entrance — —	13	10		101	01	
Goa — — —	15	30		73	50	
Fort St. George — —	13	08		81	34	
Dew Point — —	15	50		81	50	
Bengal — — —	22	27		91	49	
Malacca — — —	23	32		105	05	
Cambodia — —	10	30		104	20	
Nanquin — — —	32	55		129	30	
Iſlands in the *Eaſt Indies.*						
Abdeleur — — —	12	27	N	52	35	Eaſt Longitude.
Almircant Iſles, the Eaſtermoſt	03	42	S	52	20	
Bantam in *Javes* — —	05	37	S	105	11	
Batavia — — —	05	47	S	106	27	
Babelmandel, in the Mouth of the *Red Sea* —	12	25	N	45	45	
Borneo — — —	04	20	S	109	70	
Good Fortune — —	01	28	S	97	20	
Java, Eaſt End —	06	20	S	113	37	
Japan, S. Eaſt Point —	34	30	N	135	35	
——— S. Weſt Point —	35	20	N	126	50	
Joanna — — —	12	10	S	41	20	
Princes Iſle — —	05	47	S	105	11	
Zocatra — — —	12	28	N	54	20	
Madagaſcar, South End of *St. Sebaſtian* —	25	32	S	74	15	
Coaſt of the *Sound* and *Baltick Sea.*						
Gottenburgh — —	57	33	N	12	25	
Chriſtiana — — —	59	10	N	09	45	

Places Names.	Lat. D.	Lat. M.		Long. D.	Long. M.	Den.
Elſinore	56	00	North Latitude.	12	32	East Longitude.
Copenhagen	55	40		12	30	
Stockholm	59	20		18	25	
Vyburgh	60	20		29	26	
Peterſburgh	59	24		29	50	
Riga	56	50		24	50	
Coningſberg	55	00		20	13	
Dantzick	54	22		19	10	
Seaw	57	26		10	14	
Coaſt from the *Naze* of *Norway* to *Archangel*.						
Naze of *Norway*	57	50		07	22	
Dronton	64	00		10	40	
North Cape	71	25		22	10	
Standland	62	10		04	38	
Kilduyn	69	32		30	12	
Archangel-Bar	64	30		40	30	
Croſs Iſland	66	31		36	10	
Coaſt of Northern *Iſlands*, *Nova Zembla*, *Iceland*, and *Greenland*.						
Bear Iſle	74	35		18	12	
Hope Iſle	76	13		21	44	
Catſnoſe	65	44		33	13	
Point Lookout	76	40		16	25	
Horn Sound	77	30		13	56	
Grims Iſland	66	43		17	45	
Whales Back	65	27		10	05	
Sound Royal	66	20		14	12	

A

TABLE

OF

LOGARITHMS,

For NUMBERS increaſing in their Natural
Order from Unity to 10,000.

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
1	0.00000	46	1.66276	91	1.95904	136	2.13354
2	0.30103	47	1.67210	92	1.96379	37	2.13672
3	0.47712	48	1.68124	93	1.96848	38	2.13988
4	0.60206	49	1.69020	94	1.97313	39	2.14301
5	0.69897	50	1.69897	95	1.97772	40	2.14613
6	0.77815	51	1.70757	96	1.98227	41	2.14922
7	0.84510	52	1.71600	97	1.98677	42	2.15229
8	0.90309	53	1.72428	98	1.99123	43	2.15534
9	0.95424	54	1.73239	99	1.99564	44	2.15836
10	1.00000	55	1.74036	100	2.00000	45	2.16137
11	1.04139	56	1.74819	101	2.00432	46	2.16435
12	1.07918	57	1.75587	02	2.00860	47	2.16732
13	1.11394	58	1.76343	03	2.01284	48	2.17026
14	1.14613	59	1.77085	04	2.01703	49	2.17319
15	1.17609	60	1.77815	05	2.02119	50	2.17609
16	1.20412	61	1.78533	06	2.02533	51	2.17898
17	1.23045	62	1.79239	07	2.02938	52	2.18184
18	1.25527	63	1.79934	08	2.03342	53	2.18469
19	1.27875	64	1.80618	09	2.03743	54	2.18752
20	1.30103	65	1.81291	10	2.04139	55	2.19033
21	1.32222	66	1.81954	11	2.04532	56	2.19312
22	1.34242	67	1.82607	12	2.04922	57	2.19590
23	1.36173	68	1.83251	13	2.05308	58	2.19866
24	1.38021	69	1.83885	14	2.05690	59	2.20140
25	1.39794	70	1.84510	15	2.06071	60	2.20412
26	1.41497	71	1.85126	16	2.06446	61	2.20683
27	1.43136	72	1.85733	17	2.06819	62	2.20952
28	1.44716	73	1.89332	18	2.07188	63	2.21219
29	1.46240	74	1.86923	19	2.07555	64	2.21484
30	1.47712	75	1.87506	20	2.07918	65	2.21748
31	1.49136	76	1.88081	21	2.08279	66	2.22011
32	1.50515	77	1.88649	22	2.08636	67	2.22272
33	1.51851	78	1.89209	23	2.08991	68	2.22531
34	1.53148	79	1.89762	24	2.09342	69	2.22789
35	1.54407	80	1.90309	25	2.09691	70	2.23045
36	1.55630	81	1.90849	26	2.10037	71	2.23300
37	1.56820	82	1.91381	27	2.10380	72	2.23553
38	1.57978	83	1.91908	28	2.10721	73	2.23805
39	1.59106	84	1.92428	29	2.11059	74	2.24055
40	1.60206	85	1.92942	30	2.11394	75	2.24304
41	1.61278	86	1.93450	31	2.11727	76	2.24551
42	1.62325	87	1.93952	32	2.12057	77	2.24797
43	1.63347	88	1.94448	33	2.12385	78	2.25042
44	1.64345	89	1.94939	34	2.12710	79	2.25285
45	1.65321	90	1.95424	35	2.13033	80	2.25527

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
181	2.25768	226	2.35411	271	2.43297	316	2.49969
82	2.26007	27	2.35603	72	2.43457	17	2.50106
83	2.26245	28	2.35793	73	2.43616	18	2.50243
84	2.26482	29	2.35984	74	2.43775	19	2.50379
85	2.26717	30	2.36173	75	2.43933	20	2.50515
86	2.26951	31	2.36361	76	2.44091	21	2.50651
87	2.27184	32	2.36549	77	2.44248	22	2.50786
88	2.27416	33	2.36736	78	2.44404	23	2.50920
89	2.27646	34	2.36922	79	2.44560	24	2.51055
90	2.27875	35	2.37107	80	2.44716	25	2.51188
91	2.28103	36	2.37291	81	2.44871	26	2.51322
92	2.28330	37	2.37475	82	2.45025	27	2.51455
93	2.28556	38	2.37658	83	2.45179	28	2.51587
94	2.28780	39	2.37840	84	2.45332	29	2.51720
95	2.29003	40	2.38021	85	2.45484	30	2.51851
96	2.29226	41	2.38202	86	2.45637	31	2.51983
97	2.29447	42	2.38382	87	2.45788	32	2.52114
98	2.29667	43	2.38561	88	2.45939	33	2.52244
99	2.29885	44	2.38739	89	2.46090	34	2.52375
200	2.30103	45	2.38917	90	2.46240	35	2.52504
01	2.30320	46	2.39094	91	2.46389	36	2.52634
02	2.30535	47	2.39270	92	2.46538	37	2.52763
03	2.30750	48	2.39445	93	2.46687	38	2.52892
04	2.30963	49	2.39620	94	2.46835	39	2.53020
05	2.31175	50	2.39794	95	2.46982	40	2.53148
06	2.31387	51	2.39967	96	2.47129	41	2.53275
07	2.31597	52	2.40140	97	2.47276	42	2.53403
08	2.31806	53	2.40312	98	2.47422	43	2.53529
09	2.32015	54	2.40483	99	2.47567	44	2.53656
10	2.32222	55	2.40654	300	2.47712	45	2.53782
11	2.32428	56	2.40824	301	2.47857	40	2.53908
12	2.32634	57	2.40993	02	2.48001	47	2.54033
13	2.32838	58	2.41162	03	2.48144	48	2.54158
14	2.33041	59	2.41330	04	2.48287	49	2.54283
15	2.33241	60	2.41497	05	2.48430	50	2.54407
16	2.33445	61	2.41664	06	2.48572	51	2.54531
17	2.33646	62	2.41830	07	2.48714	52	2.54654
18	2.33846	63	2.41996	08	2.48855	53	2.54777
19	2.34044	64	2.42160	09	2.48996	54	2.54900
20	2.34242	65	2.42325	10	2.49136	55	2.55023
21	2.34439	66	2.42488	11	2.49276	56	2.55145
22	2.34635	67	2.42651	12	2.49415	57	2.55267
23	2.34830	68	2.42813	13	2.49554	58	2.55388
24	2.35025	69	2.42975	14	2.49693	59	2.55509
25	2.35218	70	1.4 136	15	2.49831	60	2.55630

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
361	2.55751	406	2.60853	451	2.65418	496	2.69548
62	2.55871	07	2.60959	52	2.65514	97	2.69636
63	2.55991	08	2.61066	53	2.65610	98	2.69723
64	2.56110	09	2.61172	54	2.65706	99	2.69810
65	2.56229	10	2.61278	55	2.65801	500	2.69897
66	2.56348	11	2.61384	56	2.65896	501	2.69984
67	2.56467	12	2.61490	57	2.65992	02	2.70070
68	2.56585	13	2.61595	58	2.66087	03	2.70157
69	2.56703	14	2.61700	59	2.66181	04	2.70243
70	2.56820	15	2.61805	60	2.66276	05	2.70329
71	2.56937	16	2.61909	61	2.66370	06	2.70415
72	2.57054	17	2.61014	62	2.66464	07	2.70501
73	2.57171	18	2.61118	63	2.66558	08	2.70586
74	2.57287	19	2.62221	64	2.66652	09	2.70672
75	2.57403	20	2.62325	65	2.66745	10	2.70757
76	2.57519	21	2.62428	66	2.66839	11	2.70842
77	2.57634	22	2.62531	67	2.66932	12	2.70927
78	2.57749	23	2.62634	68	2.67025	13	2.71012
79	2.57864	24	2.62737	69	2.67117	14	2.71096
80	2.57978	25	2.62839	70	2.67210	15	2.71181
81	2.58092	26	2.62941	71	2.67302	16	2.71265
82	2.58206	27	2.63043	72	2.67394	17	2.71349
83	2.58320	28	2.63144	73	2.67486	18	2.71433
84	2.58433	29	2.63246	74	2.67578	19	2.71517
85	2.58546	30	2.63347	75	2.67669	20	2.71600
86	2.58659	31	2.63448	76	2.67761	21	2.71684
87	2.58771	32	2.63548	77	2.67852	22	2.71767
88	2.58883	33	2.63649	78	2.67943	23	2.71850
89	2.58995	34	2.63749	79	2.68034	24	2.71933
90	2.59106	35	2.63849	80	2.68124	25	2.72016
91	2.59218	36	2.63949	81	2.68215	26	2.72099
92	2.59329	37	2.64048	82	2.68305	27	2.72181
93	2.59439	38	2.64147	83	2.68395	28	2.72263
94	2.59550	39	2.64246	84	2.68485	29	2.72346
95	2.59660	40	2.64345	85	2.68574	30	2.72428
96	2.59770	41	2.64444	86	2.68664	31	2.72509
97	2.59879	42	2.64542	87	2.68753	32	2.72591
98	2.59988	43	2.64640	88	2.68842	33	2.72673
99	2.60097	44	2.64738	89	2.68931	34	2.72754
400	2.60206	45	2.64836	90	2.69020	35	2.72835
401	2.60314	46	2.64933	91	2.69108	36	2.72916
[illegible]	[illegible]	47	2.65031	92	2.69197	37	2.72997
[illegible]	[illegible]	48	2.65128	93	2.69285	38	2.73078
[illegible]	[illegible]	[illegible]	[illegible]	94	[illegible]	39	2.73159
[illegible]	[illegible]	[illegible]	[illegible]	95	[illegible]	40	2.73239

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
541	2.73320	586	2.76790	631	2.80003	676	2.82995
42	2.73400	87	2.76864	32	2.80072	77	2.83059
43	2.73480	88	2.76938	33	2.80140	78	2.83123
44	2.73560	89	2.77012	34	2.80209	79	2.83187
45	2.73640	90	2.77085	35	2.80277	80	2.83251
46	2.73719	91	2.77159	36	2.80346	81	2.83315
47	2.73799	92	2.77232	37	2.80414	82	2.83378
48	2.73878	93	2.77305	38	2.80482	83	2.83442
49	2.73957	94	2.77379	39	2.80550	84	2.83506
50	2.74036	95	2.77452	40	2.80618	85	2.83567
51	2.74115	96	2.77525	41	2.80686	86	2.83632
52	2.74194	97	2.77597	42	2.80754	87	2.83696
53	2.74273	98	2.77670	43	2.80821	88	2.83759
54	2.74351	99	2.77743	44	2.80889	89	2.83822
55	2.74429	600	2.77815	45	2.80956	90	2.83885
56	2.74507	601	2.77887	46	2.81023	91	2.83948
57	2.74586	02	2.77960	47	2.81090	92	2.84011
58	2.74663	03	2.78032	48	2.81158	93	2.84073
59	2.74741	04	2.78104	49	2.81224	94	2.84136
60	2.74819	05	2.78176	50	2.81292	95	2.84198
61	2.74896	06	2.78247	51	2.81358	96	2.84261
62	2.74974	07	2.78319	52	2.81425	97	2.84323
63	2.75051	08	2.78390	53	2.81491	98	2.84386
64	2.75128	09	2.78462	54	2.81558	99	2.84448
65	2.75205	10	2.78533	55	2.81624	700	2.84510
66	2.75282	11	2.78604	56	2.81690	701	2.84572
67	2.75358	12	2.78675	57	2.81757	02	2.84634
68	2.75435	13	2.78746	58	2.81823	03	2.84696
69	2.75511	14	2.78816	59	2.81889	04	2.84757
70	2.75587	15	2.78888	60	2.81954	05	2.84819
71	2.75664	16	2.78958	61	2.82020	06	2.84880
72	2.75740	17	2.79029	62	2.82086	07	2.84942
73	2.75815	18	2.79099	63	2.82151	08	2.85003
74	2.75891	19	2.79169	64	2.82217	09	2.85065
75	2.75967	20	2.79239	65	2.82282	10	2.85126
76	2.76042	21	2.79309	66	2.82347	11	2.85187
77	2.76118	22	2.79379	67	2.82413	12	2.85248
78	2.76193	23	2.79449	68	2.82478	13	2.85309
79	2.76268	24	2.79518	69	2.82543	14	2.85370
80	2.76343	25	2.79588	70	2.82607	15	2.85431
81	2.76418	26	2.79657	71	2.82672	16	2.85491
82	2.76492	27	2.79727	72	2.82737	17	2.85552
83	2.76567	28	2.79796	73	2.82802	18	2.85612
84	2.76641	29	2.79865	74	2.82866	19	2.85673
85	2.76716	30	2.79934	75	2.82930	20	2.85733

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
721	2.85794	766	2.88423	811	2.90902	856	2.93247
22	2.85854	67	2.88480	12	2.90956	57	2.93298
23	2.85914	68	2.88536	13	2.91009	58	2.93349
24	2.85974	69	2.88593	14	2.91062	59	2.93399
25	2.86034	70	2.88649	15	2.91116	60	2.93450
26	2.86094	71	2.88705	16	2.91169	61	2.93500
27	2.86153	72	2.88762	17	2.91222	62	2.93551
28	2.86213	73	2.88818	18	2.91217	63	2.93601
29	2.86273	74	2.88874	19	2.91328	64	2.93651
30	2.86332	75	2.88930	20	2.91381	65	2.93702
31	2.86392	76	2.88986	21	2.91434	66	2.93752
32	2.86451	77	2.89042	22	2.91487	67	2.93802
33	2.86510	78	2.89098	23	2.91540	68	2.93852
34	2.86570	79	2.89154	24	2.91593	69	2.93902
35	2.86629	80	2.89209	25	2.91645	70	2.93952
36	2.86688	81	2.89265	26	2.91698	71	2.94002
37	2.86747	82	2.89321	27	2.91751	72	2.94052
38	2.86806	83	2.89376	28	2.91803	73	2.94101
39	2.86864	84	2.89432	29	2.91855	74	2.94151
40	2.86923	85	2.89487	30	2.91908	75	2.94201
41	2.86982	86	2.89542	31	2.91960	76	2.94250
42	2.87040	87	2.89597	32	2.92012	77	2.94300
43	2.87099	88	2.89653	33	2.92065	78	2.94349
44	2.87157	89	2.89708	34	2.92117	79	2.94399
45	2.87216	90	2.89763	35	2.92169	80	2.94448
46	2.87274	91	2.89818	36	2.92221	81	2.94498
47	2.87332	92	2.89873	37	2.92273	82	2.94547
48	3.87390	93	2.89927	38	2.92324	83	2.94596
49	2.87448	94	2.89982	39	2.92376	84	2.94645
50	2.87506	95	2.90037	40	2.92428	85	2.94694
51	2.87564	96	2.90091	41	2.92480	86	2.94743
52	2.87622	97	2.90146	42	2.92531	87	2.94792
53	2.87680	98	2.90200	43	2.92583	88	2.94841
54	2.87737	99	2.90255	44	2.92634	89	2.94890
55	2.87795	800	2.90309	45	2.92686	90	2.94939
56	2.87852	801	2.90363	49	2.92737	91	2.94988
57	2.87910	02	2.90417	47	2.92788	92	2.95036
58	2.87967	03	2.90472	48	2.92840	93	2.95085
59	2.88024	04	2.90526	49	2.92891	94	2.95134
60	2.88081	05	2.90580	50	2.92942	95	2.95182
61	2.88138	06	2.90634	51	2.92993	96	2.95231
62	2.88196	07	2.90687	52	2.93044	97	2.95279
63	2.88252	08	2.90741	53	2.93095	98	2.95328
64	2.88309	09	2.90795	54	2.93146	99	2.95376
65	2.88366	10	2.90849	55	2.93197	900	2.95424

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
901	2.95472	946	2.97589	991	2.99607	1036	3.01536
02	2.95521	47	2.97635	92	2.99651	37	3.01578
03	2.95569	48	2.97681	93	2.99695	38	3.01620
04	2.95617	49	2.97727	94	2.99739	39	3.01662
05	2.95665	50	2.97772	95	2.99782	40	3.01703
06	2.95713	51	2.97818	96	2.99826	41	3.01745
07	2.95761	52	2.97864	97	2.99870	42	3.01787
08	2.95809	53	2.97909	98	2.99913	43	3.01828
09	2.95856	54	2.97955	99	2.99957	44	3.01870
10	2.95904	55	2.98000	1000	3.00000	45	3.01912
11	2.95952	56	2.98046	1001	3.00043	46	3.01953
12	2.95999	57	2.98091	02	3.00087	47	3.01995
13	2.96047	58	2.98137	03	3.00130	48	3.02036
14	2.96095	59	2.98182	04	3.00173	49	3.02078
15	2.96142	60	2.98227	05	3.00217	50	3.02119
16	2.96190	61	2.98272	06	3.00260	51	3.02160
17	2.96237	62	2.98318	07	3.00303	52	3.02202
18	2.96284	63	2.98363	08	3.00346	53	3.02243
19	2.96332	64	2.98408	09	3.00389	54	3.02284
20	2.96379	65	2.98453	10	2.00432	55	3.02325
21	2.96426	66	2.98498	11	3.00475	56	3.02366
22	2.96473	67	2.98543	12	3.00518	57	3.02408
23	2.96520	68	2.98588	13	3.00561	58	3.02449
24	2.96567	69	2.98632	14	3.00604	59	3.02490
25	2.96614	70	2.98677	15	3.00647	60	3.02531
26	2.96661	71	2.98722	16	3.00689	61	3.02572
27	2.96708	72	2.98767	17	3.00732	62	3.02613
28	2.96755	73	2.98811	18	3.00774	63	3.02653
29	2.96806	74	2.98856	19	3.00817	64	3.02694
30	2.96848	75	2.98900	20	3.00860	65	3.02735
31	2.96895	76	2.98945	21	3.00903	66	3.02776
32	2.96942	77	2.98989	22	3.00945	67	3.02816
33	2.96988	78	2.99034	23	3.00988	68	3.02857
34	2.97035	79	2.99078	24	3.01030	69	3.02898
35	2.97081	80	2.99123	25	3.01072	70	3.02938
36	2.47128	81	2.99167	20	3.01115	71	3.02979
37	2.97174	82	2.99211	27	3.01157	72	3.03019
38	2.97220	83	2.99255	28	3.01199	73	3.03060
39	2.97267	84	2.99300	29	3.01242	74	3.03100
40	2.97313	85	2.99344	30	3.01284	75	3.03141
41	2.97359	86	2.99388	31	3.01326	76	3.03181
42	2.97405	87	2.99432	32	3.01368	77	3.03222
43	2.97451	88	2.99476	33	3.01410	78	3.03262
44	2.97497	86	2.99520	34	3.01452	79	3.03302
45	2.97543	90	2.99564	35	3.01494	80	3.03342

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1081	3.03383	1126	3.05154	1171	3.06856	1216	3.08493
82	3.03423	27	3.05192	72	3.06893	17	3.08529
83	3.03463	28	3.05231	73	3.06930	18	3.08565
84	3.03503	29	3.05269	74	3.06967	19	3.08600
85	3.03543	30	3.05308	75	3.07004	20	3.08636
86	3.03583	31	3.05346	76	3.07041	21	3.08672
87	3.03623	32	3.05385	77	3.07078	22	3.08707
88	3.03663	33	3.05423	78	3.07115	23	3.08743
89	3.03703	34	3.05461	79	3.07151	24	3.08778
90	3.03743	35	3.05500	80	3.07188	25	3.08814
91	3.03782	36	3.05538	81	3.07225	26	3.08849
92	3.03822	37	3.05576	82	3.07262	27	3.08884
93	3.03862	38	3.05614	83	3.07298	28	3.08920
94	3.03902	39	3.05652	84	3.07335	29	3.08955
95	3.03941	40	3.05690	85	3.07372	30	3.08991
96	3.03981	41	3.05729	86	3.07408	31	3.09026
97	3.04021	42	3.05767	87	3.07445	32	3.09061
98	3.04060	43	3.05805	88	3.07482	33	3.09096
99	3.04100	44	3.05843	89	3.07518	34	3.09132
1100	3.04139	45	3.05881	90	3.07555	35	2.09167
1001	3.04179	46	3.05919	91	3.07591	36	3.09202
02	3.04218	47	3.05956	92	3.07628	37	3.09237
03	3.04258	48	3.05994	93	3.07664	38	3.09272
04	3.04297	49	3.06032	94	3.07700	39	3.09307
05	3.04336	50	3.06070	95	3.07737	40	3.09342
06	2.04376	51	3.06108	96	3.07773	41	3.09377
07	3.04415	52	3.06145	97	3.07809	42	3.09412
08	3.04454	53	3.06183	98	3.07846	43	3.09447
09	3.04493	54	3.06221	99	3.07882	44	3.09482
10	3.04532	55	3.06258	1200	3.07918	45	3.09517
11	3.04571	56	3.06296	1201	3.07954	46	3.09552
12	3.04610	57	3.06333	02	3.07990	47	3.09587
13	3.04650	58	3.06371	03	3.08027	48	3.09621
14	3.04689	59	3.06408	04	3.08063	49	3.09656
15	3.04727	60	3.06446	05	3.08099	50	3.09691
16	3.04766	61	3.06483	06	3.08135	51	3.09726
17	3.04805	62	3.06521	07	3.08171	52	3.09760
18	3.04844	63	3.06558	08	3.08207	53	3.09795
19	3.04883	64	3.06595	09	3.08243	54	3.09830
20	3.04922	65	3.06633	10	2.08279	55	3.09864
21	3.04961	66	3.06670	11	3.08314	56	3.09899
22	3.04999	67	3.06707	12	3.08350	57	3.09934
23	3.05038	68	3.06744	13	3.08386	58	3.09968
24	3.05077	69	3.06781	14	3.08422	59	3.10003
25	3.05115	70	3.06819	15	3.08548	60	3.10037

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1261	3.10072	1306	3.11594	1351	3.13066	1396	3.14489
62	3.10106	07	3.11628	52	3.13098	97	3.14520
63	3.10140	08	3.11661	53	3.13130	98	3.14551
64	3.10175	09	3.11694	54	3.13162	99	3.14582
65	3.10209	10	3.11727	55	3.13194	1400	3.14613
66	3.10243	11	3.11760	56	3.13226	1401	3.14644
67	3.10278	12	3.11793	57	3.13258	02	3.14675
68	3.10312	13	3.11826	58	3.13290	03	3.14706
69	3.10346	14	3.11860	59	3.13322	04	3.14737
70	3.10380	15	3.11893	60	3.13354	05	3.14768
71	3.10415	16	3.11926	61	3.13386	06	3.14799
72	3.10449	17	3.11959	62	3.13418	07	3.14829
73	3.10483	18	3.11992	63	3.13450	08	3.14860
74	3.10517	19	3.12024	64	3.13481	09	3.14891
75	3.10551	20	3.12057	65	3.13513	10	3.14922
76	3.10585	21	3.12090	66	3.13545	11	3.14953
77	3.10619	22	3.12123	67	3.13577	12	3.14983
78	3.10653	23	3.12156	68	3.13609	13	3.15014
79	3.10687	24	3.12189	69	3.13640	14	3.15045
80	3.10721	25	3.12222	70	3.13672	15	3.15076
81	3.10755	26	3.12254	71	3.13704	16	3.15106
82	3.10789	27	3.12287	72	3.13735	17	3.15137
83	3.10823	28	3.12320	73	3.13767	18	3.15168
84	3.10857	29	3.12353	74	3.13799	19	3.15198
85	3.10890	30	3.12385	75	3.13830	20	3.15229
86	3.10924	31	3.12418	76	3.13862	21	3.15259
87	3.10958	32	3.12450	77	3.13893	22	3.15290
88	3.10992	33	3.12483	78	3.13925	23	3.15320
89	3.11025	34	3.12516	79	3.13956	24	3.15351
90	3.11059	35	3.12548	80	3.13988	25	3.15381
91	3.11093	36	3.12581	81	3.14019	26	3.15412
92	3.11126	37	3.12613	82	3.14051	27	3.15442
93	3.11160	38	3.12646	83	3.14082	28	3.15473
94	3.11193	39	3.12678	84	3.14114	29	3.15503
95	3.11227	40	3.12710	85	3.14145	30	3.15534
96	3.11261	41	3.12743	86	3.14176	31	3.15564
97	3.11294	42	3.12775	87	3.14208	32	3.15594
98	3.11327	43	3.12808	88	3.14239	33	3.15625
99	3.11361	44	3.12840	89	3.14270	34	3.15655
1300	3.11394	45	3.12872	90	3.14301	35	3.15685
1301	3.11428	46	3.12905	91	3.14333	36	3.15715
02	3.11461	47	3.12937	92	3.14364	37	3.15746
03	3.11494	48	3.12969	93	3.14395	38	3.15776
04	3.11528	49	3.13001	94	3.14426	39	3.15806
05	3.11561	50	3.13033	95	3.14457	40	3.15836

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1441	3.15866	1486	3.17202	1531	3.18498	1576	3.19756
42	3.15897	87	3.17231	32	3.18526	77	3.19783
43	3.15927	88	3.17260	33	3.18554	78	3.19811
44	3.15957	89	3.17289	34	3.18583	79	3.19838
45	3.15987	90	3.17319	35	3.18511	80	3.19866
46	3.16017	91	3.17348	36	3.18639	81	3.19893
47	3.16047	92	3.17377	37	3.18667	82	3.19921
48	3.16077	93	3.17406	38	3.18696	83	3.19948
49	3.16107	94	3.17435	39	3.18724	84	3.19576
50	3.16137	95	3.17464	40	3.18752	85	3.20003
51	3.16167	96	3.17493	41	3.18780	86	3.20030
52	3.16197	97	3.17522	42	3.18808	87	3.20058
53	3.16227	98	3.17551	43	3.18837	88	3.20085
54	3.16256	96	3.17580	44	3.18865	89	3.20112
55	3.16286	1500	3.17609	45	3.18893	90	3.20140
56	3.16316	1501	3.17638	46	3.18921	91	3.20167
57	3.16346	02	3.17667	47	3.18949	92	3.20194
58	3.16376	03	3.17696	48	3.18977	93	3.20222
59	3.16406	04	3.17725	49	3.19005	94	3.20249
60	3.16435	05	3.17754	50	3.19033	95	3.20276
61	3.16465	06	3.17783	51	3.19061	96	3.20303
62	3.16495	07	3.17811	52	3.19089	97	3.20330
63	3.16524	08	3.17840	53	3.19117	98	3.20358
64	3.16554	09	3.17869	54	3.19145	99	3.20385
65	3.16584	10	3.17898	55	3.19173	1600	3.20412
66	3.16613	11	3.17926	56	3.19201	1601	3.20439
67	3.16643	12	3.17955	57	3.19229	02	3.20466
68	3.16673	13	3.17984	58	3.19257	03	3.20493
69	3.16702	14	3.18013	59	3.19285	04	3.20520
70	3.16732	15	3.18041	60	3.19312	05	3.20548
71	3.16761	16	3.18070	61	3.19340	06	3.20575
72	3.16791	17	3.18099	62	3.19368	07	3.20602
73	3.16820	18	3.18127	63	3.19396	08	3.20629
74	3.16850	19	3.18156	64	3.19424	09	3.20656
75	3.16879	20	3.18184	65	3.19451	10	3.20683
76	3.16909	21	3.18213	66	3.19479	11	3.20710
77	3.16938	22	3.18341	67	3.19507	12	3.20737
78	3.16967	23	3.18270	68	3.19535	13	3.20763
79	3.16997	24	3.18299	69	3.19562	14	3.20790
80	3.17026	25	3.18327	70	3.19590	15	3.20817
81	3.17056	26	3.18355	71	3.19618	16	3.20844
82	3.17085	27	3.18384	72	3.19645	17	3.20871
83	3.17114	28	3.18412	73	3.19673	18	3.20898
84	3.17143	29	3.18441	74	3.19700	19	3.20925
85	3.17173	30	3.18469	75	3.19728	20	3.20952

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
1621	3.20978	1666	3.22168	1711	3.23325	1756	3.24452
22	3.21005	67	3.22194	12	3.23350	57	3.24477
23	3.21032	68	3.22220	13	3.23376	58	3.24502
24	3.21059	69	3.22246	14	3.23401	59	3.24527
25	3.21085	70	3.22272	15	3.23426	60	3.24551
26	3.21112	71	3.22298	16	3.23452	61	3.24576
27	3.21139	72	3.22324	17	3.23477	62	3.24601
28	3.21165	73	3.22350	18	3.23502	63	3.24625
29	3.21192	74	3.22376	19	3.23528	64	3.24650
30	3.21219	75	3.22401	20	3.23553	65	3.24674
31	3.21245	76	3.22427	21	3.23578	66	3.24699
32	3.21272	77	3.22453	22	3.23603	67	3.24724
33	3.21299	78	3.22479	23	3.23629	68	3.24748
34	3.21325	79	3.22505	24	3.23654	69	3.24773
35	3.21352	80	3.22531	25	3.23679	70	3.24797
36	3.21378	81	3.22557	26	3.23704	71	3.24822
37	3.21405	82	3.22583	27	3.23729	72	3.24846
38	3.21431	83	3.22608	28	3.23754	73	3.24871
39	3.21458	84	3.22634	29	3.23780	74	3.24895
40	3.21484	85	3.22660	30	3.23805	75	3.24920
41	3.21511	86	3.22686	31	3.23830	76	3.24944
42	3.21537	87	3.22712	32	3.23855	77	3.24969
43	3.21564	88	3.22737	33	3.23880	78	3.24993
44	3.21590	89	3.22763	34	3.23905	79	3.25018
45	3.21617	90	3.22789	35	3.23930	80	3.25042
46	3.21643	91	3.22814	36	3.23955	81	3.25066
47	3.21669	92	3.22849	37	3.23980	82	3.25091
48	3.21696	93	3.22866	38	3.24005	83	3.25115
49	3.21722	94	3.22891	39	3.24030	84	3.25139
50	3.21748	95	3.22917	40	3.24055	85	3.25164
51	3.21775	96	3.22943	41	3.24080	86	3.25188
52	3.21801	97	3.22968	42	3.24105	87	3.25212
53	3.21827	98	3.22994	43	3.24130	88	3.25237
54	3.21854	99	3.23019	44	3.24155	89	3.25261
55	3.21880	1700	3.23045	45	3.24180	90	3.25285
56	3.21906	1701	3.23070	46	3.24204	91	3.25310
57	3.21932	02	3.23096	47	3.24229	92	3.25334
58	3.21958	03	3.23121	48	3.24254	93	3.25358
59	3.21985	04	3.23147	49	3.24279	94	3.25382
60	3.22011	05	3.23172	50	3.24304	95	3.25306
61	3.22037	06	3.23198	51	3.24329	96	3.25431
62	3.22063	07	3.23223	52	3.24353	97	3.25455
63	3.22089	08	3.23249	53	3.24378	98	3.25479
64	3.22115	09	3.23274	54	3.24403	99	3.25503
65	3.22141	10	3.23300	55	3.24428	1800	3.25527

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1801	3.25551	1846	3.26623	1891	3.27669	1936	3.28691
02	3.25575	47	3.26647	92	3.27692	37	3.28713
03	3.25600	48	3.26670	93	3.27715	38	3.28735
04	3.25624	49	3.26694	94	3.27738	39	3.28758
05	3.25648	50	3.26717	95	3.27761	40	3.28780
06	3.25672	51	3.26741	96	3.27784	41	3.28803
07	3.25696	52	3.26764	97	3.27807	42	3.28825
08	3.25720	53	3.26788	98	3.27830	43	3.28847
09	3.25744	54	3.26811	99	3.27853	44	3.28870
10	3.25768	55	3.26834	1900	3.27875	45	3.28892
11	3.25792	56	3.26858	1901	3.27898	46	3.28914
12	3.25816	57	3.26881	02	3.27921	47	3.28937
13	3.25840	58	3.26905	03	3.27944	48	3.28959
14	3.25864	59	3.26928	04	3.27967	49	3.28981
15	3.25888	60	3.26951	05	3.27990	50	3.29003
16	3.25912	61	3.26975	06	3.28012	51	3.29026
17	3.25935	62	3.26998	07	3.28035	52	3.29048
18	3.25960	63	3.27021	08	3.28058	53	3.29070
19	3.25983	64	3.27045	09	3.28081	54	3.29092
20	3.26007	65	3.27068	10	3.28103	55	3.29115
21	3.26031	66	3.27091	11	3.28126	56	3.29137
22	3.26055	67	3.27114	12	3.28149	57	3.29159
23	3.26079	68	3.27138	13	3.28172	58	3.29181
24	3.26102	69	3.27161	14	3.28194	59	3.29203
25	3.26126	70	3.27184	15	3.28217	60	3.29226
26	3.26150	71	3.27207	16	3.28240	61	3.29248
27	3.26174	72	3.27231	17	3.28262	62	3.29270
28	3.26198	73	3.27254	18	3.28285	63	3.29292
29	3.26221	74	3.27277	19	3.28308	64	3.29314
30	3.26245	75	3.27300	20	3.28330	65	3.29336
31	3.26269	76	3.27323	21	3.28353	66	3.29358
32	3.26293	77	3.27346	22	3.28375	67	3.29380
33	3.26316	78	3.27370	23	3.28398	68	3.29403
34	3.26340	79	3.27393	24	3.28421	69	3.29425
35	3.26364	80	3.27416	25	3.28444	70	3.29447
36	3.26387	81	3.27439	26	3.28466	71	3.29469
37	3.26411	82	3.27462	27	3.28488	72	3.29491
38	3.26435	83	3.27485	28	3.28511	73	3.29513
39	3.26458	84	3.27508	29	3.28533	74	3.29535
40	3.26482	85	3.27531	30	3.28556	75	3.29557
41	3.26505	86	3.27554	31	3.28578	76	3.29579
42	3.26529	87	3.27577	32	3.28601	77	3.29601
43	3.26553	88	3.27600	33	3.28623	78	3.29623
44	3.26576	89	3.27623	34	3.28646	79	3.29645
45	3.26600	90	3.27646	35	3.28668	80	3.29667

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
1981	3.29688	2026	3.30664	2071	3.31618	2116	3.32552
82	3.29710	27	3.30685	72	3.31639	17	3.32572
83	3.29732	28	3.30707	73	3.31660	18	3.32593
84	3.29754	29	3.30728	74	3.31681	19	3.32613
85	3.29776	30	3.30750	75	3.31702	20	3.32634
86	3.29798	31	3.30771	76	3.31723	21	3.32654
87	3.29820	32	3.30792	77	3.31744	22	3.32675
88	3.29842	33	3.30814	78	3.31765	23	3.32695
89	3.29863	34	3.30835	79	3.31785	24	3.32715
90	3.29885	35	3.30856	80	3.31806	25	3.32736
91	3.29907	36	3.30878	81	3.31827	26	3.32756
92	3.29929	37	3.30899	82	3.31848	27	3.32777
93	3.29951	38	3.30920	83	3.31869	28	3.32797
94	3.29973	39	3.30942	84	3.31890	29	3.32818
95	3.29994	40	3.30963	85	3.31911	30	3.32838
96	3.30016	41	3.30984	86	3.31931	31	3.32858
97	3.30038	42	3.31006	87	3.31952	32	3.32879
98	3.30060	43	3.31027	88	3.31973	33	3.32899
99	3.30081	44	3.41048	89	3.31994	34	3.32919
2000	3.30103	45	3.31069	90	3.32015	35	3.32940
2001	3.30125	46	3.31091	91	3.32035	36	3.32960
02	3.30146	47	3.31112	92	3.32056	37	3.32980
03	3.30168	48	4.31133	93	3.32077	38	3.33001
04	3.30190	49	3.31154	94	3.32098	39	3.33021
05	3.30211	50	3.31175	95	3.32118	40	3.33041
06	3.30233	51	3.31197	96	3.32139	41	3.33062
07	3.30255	52	3.31218	97	3.32160	42	3.33082
08	3.30276	53	3.31239	98	3.32181	43	3.33102
09	3.30298	54	3.31260	99	3.32201	44	3.33122
10	3.30320	55	3.31281	2100	3.32222	45	3.33143
11	3.30341	56	3.31302	2101	3.32243	46	3.33163
12	3.30363	57	3.31323	02	3.32263	47	3.33183
13	3.30384	58	3.31345	03	3.32284	48	3.33203
14	3.30406	59	3.31366	04	3.32305	49	3.33224
15	3.30428	60	3.31387	05	3.32325	50	3.33244
16	3.30449	61	3.31408	06	3.32346	51	3.33264
17	3.30471	62	3.31429	07	3.32366	52	3.33284
18	3.30492	63	3.31450	08	3.32387	53	3.33304
19	3.30514	64	3.31471	09	3.32408	54	3.33325
20	3.30535	65	3.31492	10	3.32428	55	3.33345
21	3.30557	66	3.31513	11	3.32449	56	3.33365
22	3.30578	67	3.31534	12	3.32469	57	3.33385
23	3.30600	68	3.31555	13	3.32490	58	3.33405
24	3.30621	69	3.31576	14	3.32511	59	3.33425
25	3.30643	70	3.31597	15	3.32531	60	3.33445

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
2161	3·33465	2206	3·34361	2251	3·35238	2296	3·36097
62	3·33486	07	3·34380	52	3·35257	97	3·36116
63	3·33506	08	3·34400	53	3·35276	98	3·36135
64	3·33526	09	3·34420	54	3·35295	99	3·36154
65	3·33546	10	3·34439	55	3·35315	2300	3·36173
66	3·33566	11	3·34459	56	3·35334	2301	3·36192
67	3·33586	12	3·34479	57	3·35353	02	3·36211
68	3·33606	13	3·34498	58	3·35372	03	3·36229
69	3·33626	14	3·34518	59	3·35392	04	3·36248
70	3·33646	15	3·34537	60	3·35411	05	3·36267
71	3·33666	16	3·34557	61	3·35430	06	3·36286
72	3·33686	17	3·34577	62	3·35449	07	3·36305
73	3·33706	18	3·34596	63	3·35468	08	3·36324
74	3·33726	19	3·34616	64	3·35488	09	3·36342
75	3·33746	20	3·34635	65	3·35507	10	3·36361
76	3·33766	21	3·34655	66	3·35526	11	3·36380
77	3·33786	22	3·34674	67	3·35545	12	3·36399
78	3·33806	23	3·34694	68	3·35564	13	3·36418
79	3·33826	24	3·34713	69	3·35583	14	3·36436
80	3·33846	25	3·34733	70	3·35603	15	3·36455
81	3·33866	26	3·34753	71	3·35622	16	3·36474
82	3·33886	27	3·34772	72	3·35641	17	3·36493
83	3·33905	28	3·34792	73	3·35660	18	3·36511
84	3·33925	29	3·34811	74	3·35679	19	3·36530
85	3·33945	30	3·24830	75	3·35698	20	3·36549
86	3·33965	31	3·34850	76	3·35717	21	3·36568
87	3·33985	32	3·34869	77	3·35736	22	3·36586
88	3·34005	33	3·34889	78	3·35755	23	3·36605
89	3·34025	34	3·34908	79	3·35774	24	3·36624
90	3·34044	35	3·34928	80	3·35793	25	3·36642
91	3·34064	36	3·34947	81	3·35813	26	3·36661
92	3·34084	37	3·34967	82	3·35832	27	3·36680
93	3·34104	38	3·34987	83	3·35851	28	3·36698
94	3·34124	39	3·35005	84	3·35870	29	3·36717
95	3·34143	40	3·35025	85	3·35889	30	3·36736
96	3·34163	41	3·35044	86	3·35908	31	3·36754
97	3·34183	42	3·35064	87	3·35927	32	3·36773
98	3·34203	43	3·35083	88	3·35946	33	3·36791
99	3·34223	44	3·35102	98	3·35965	34	3·36810
2200	3·34242	45	3·35122	90	3·35984	35	3·36829
2201	3·34262	46	3·35141	91	3·36003	36	3·36847
02	3·34282	47	3·35160	92	3·36021	37	3·36866
03	3·34301	48	3·35180	93	3·36040	38	3·36884
04	3·34321	49	3·35199	94	3·36059	39	3·36903
05	3·34341	50	3·35218	95	3·36078	40	3·36922

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
2341	3.36940	2386	3.37767	2431	3.38579	2476	3.39375
42	3.36959	87	3.37785	32	3.38596	77	3.39393
43	3.36977	88	3.37803	33	3.38614	78	3.39410
44	3.36996	89	3.37822	34	3.38632	79	3.39428
45	3.37014	90	3.37840	35	3.38650	80	3.39445
46	3.37033	91	3.37858	36	3.38668	81	3.39463
47	3.37051	92	3.37876	37	3.38686	82	3.39480
48	3.37070	93	3.37894	38	3.38703	83	3.39498
49	3.37088	94	3.37912	39	3.38721	84	3.39515
50	3.37107	95	3.37931	40	3.38739	85	3.39533
51	3.37125	96	3.37949	41	3.38757	86	3.39550
52	3.37144	97	3.37967	42	3.38775	87	3.39568
53	3.37162	98	3.37985	43	3.38792	88	3.39585
54	3.37181	99	3.38003	44	3.38810	89	3.39602
55	3.37199	2400	3.38021	45	3.38828	90	3.39620
56	3.37218	2401	3.38039	46	3.38846	91	3.39637
57	3.37236	02	3.38057	47	3.38863	92	3.39655
58	3.37254	03	3.38075	48	3.38881	93	3.39672
59	3.37273	04	3.48093	49	3.38899	94	3.39690
60	3.37291	05	3.38112	50	3.38917	95	3.39707
61	3.37310	06	3.38130	51	3.38934	96	3.39724
62	3.37328	07	3.38146	52	3.38952	97	3.39741
63	3.37346	08	4.38166	53	3.38970	98	3.39749
64	3.37365	09	3.38184	55	3.38988	99	3.39777
65	3.37383	10	3.38202	55	3.38005	2500	3.39794
66	3.37401	11	3.38220	56	3.39022	2501	3.39811
67	3.37420	12	3.38238	57	3.39041	02	3.39829
68	3.37438	13	3.38256	58	3.39058	03	3.39846
69	3.37457	14	3.38274	59	3.39076	04	3.39863
70	3.37475	15	3.38292	60	3.39094	05	3.39881
71	3.37493	16	3.38310	61	3.39111	06	3.39898
72	3.37511	17	3.38328	62	3.39129	07	3.39915
73	3.37530	18	3.38346	63	3.39146	08	3.39933
74	3.37548	19	4.38364	64	3.39164	09	3.39950
75	3.37566	20	3.38382	65	3.39182	10	3.39967
76	3.37585	21	3.38399	66	3.39199	11	3.39985
77	3.37603	22	3.38417	67	3.39217	12	3.40002
78	3.37621	23	3.38435	68	3.39235	13	3.40019
79	3.37639	24	3.38453	69	3.39252	14	3.40037
80	3.37658	25	3.38471	70	3.39270	15	3.40054
81	3.37676	26	3.38489	71	3.39287	16	3.40071
82	3.37694	27	3.38507	72	3.39305	17	3.40088
83	3.37712	28	3.38525	73	3.39322	18	3.40106
84	3.37731	29	3.38543	74	3.39340	19	3.40123
85	3.37749	30	3.38561	75	3.39358	20	3.40140

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
2521	3·40157	2566	3·40926	2611	3·41681	2656	3·42423
22	3·40175	67	3·40943	12	3·41697	57	3·42439
23	3·40192	68	3·40960	13	3·41714	58	3·42456
24	3·40209	69	3·40976	14	3·41731	59	3·42472
25	3·40226	70	3·40993	15	3·41747	60	3·42488
26	3·40243	71	3·41010	16	3·41764	61	3·42504
27	3·40261	72	3·41027	17	3·41780	62	3·42521
28	3·40278	73	3·41044	18	3·41797	63	3·42537
29	3·40295	74	3·41061	19	3·41814	64	3·42553
30	3·40312	75	3·41078	20	3·41830	65	3·42570
31	3·40329	76	3·41095	21	3·41847	66	3·42586
32	3·40346	77	3·41111	22	3·41863	67	3·42602
33	3·40364	78	3·41128	23	3·41880	68	3·42619
34	3·40381	79	3·41145	24	3·41896	69	3·42635
35	3·40398	80	3·41162	25	3·41913	70	3·42651
36	3·40415	81	3·41179	26	3·41929	71	3·42667
37	3·40432	82	3·41196	27	3·41946	72	3·42684
38	3·40449	83	3·41212	28	3·41963	73	3·42700
39	3·40466	84	3·41229	29	3·41979	74	3·42716
40	3·40483	85	3·41246	30	3·41996	75	3·42732
41	3·40500	86	3·41263	31	3·42012	76	3·42749
42	3·40518	87	3·41280	32	3·42029	77	3·42765
43	3·40535	88	3·41296	33	3·42045	78	3·42781
44	3·40552	89	3·41313	34	3·42062	79	3·42797
45	3·40569	90	3·41330	35	3·42078	80	3·42813
46	3·40586	91	3·41347	36	3·42095	81	3·42830
47	3·40603	92	3·41364	37	3·42111	82	3·42846
48	3·40620	93	3·41380	38	3·42127	83	3·42862
49	3·40637	94	3·41397	39	3·42144	84	3·42878
50	3·40654	95	3·41414	40	3·42160	85	3·42894
51	3·40671	96	3·41430	41	3·42177	86	3·42911
52	3·40688	97	3·41447	42	3·42193	87	3·42927
53	3·40705	98	3·41464	43	3·42210	88	3·42943
54	3·40722	99	3·41481	44	3·42226	89	3·42959
55	3·40739	2600	3·41497	45	3·42243	90	3·42975
56	3·40756	2601	3·41514	46	3·42259	91	3·42991
57	3·40773	02	3·41531	47	3·42275	92	3·43008
58	3·40790	03	3·41547	48	3·42292	93	3·43024
59	3·40807	04	3·41564	49	3·42309	94	3·43040
60	3·40824	05	3·41581	50	3·42325	95	3·43056
61	3·40841	06	3·41597	51	3·42341	96	3·43072
62	3·40858	07	3·41614	52	3·42357	97	3·43088
63	3·40875	08	3·41631	53	3·42374	98	3·43104
64	3·40892	09	3·41647	54	3·42390	99	3·43120
65	3·40909	10	3·41664	55	3·42401	2700	3·43136

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
2701	3·43152	2446	3·43870	2791	3·44576	2836	3·45271
02	3·43169	47	3·43886	92	3·44592	37	3·45286
03	3·43185	48	3·43902	93	3·44607	38	3·45301
04	3·43201	49	3·43917	94	3·44623	39	3·45317
05	3·43217	50	3·43933	95	3·44638	40	3·45332
06	3·43233	51	3·43949	96	3·44654	41	3·45347
07	3·43249	52	3·43965	97	3·44669	42	3·45362
08	3·43265	53	3·43981	98	3·44685	43	3·45378
09	3·43281	54	3·43996	99	3·44700	44	3·45393
10	3·43297	55	3·44012	2800	3·44716	45	3·45408
11	3·43313	56	3·44028	2801	3·44731	46	3·45423
12	3·43329	57	3·44044	02	3·44747	47	3·45439
13	3·43345	58	3·44059	03	3·44762	48	3·45454
14	3·43361	59	3·44075	04	3·44778	49	3·45469
15	3·43377	60	3·44091	05	3·44793	50	3·45484
16	3·43393	61	3·44107	06	3·44809	51	3·45500
17	3·43409	62	3·44122	07	3·44824	52	3·45515
18	3·43425	63	3·44138	08	3·44840	53	3·45530
19	3·43441	64	3·44154	09	3·44855	54	3·45545
20	3·43457	65	3·44170	10	3·44871	55	3·45561
21	3·43473	66	3·44185	11	3·44886	56	3·45576
22	3·43489	67	3·44201	12	3·44902	57	3·45591
23	3·43505	68	3·44217	13	3·44917	58	3·45606
24	3·43521	69	3·44232	14	3·44932	59	3·45621
25	3·43537	70	3·44248	15	3·44948	60	3·45637
26	3·43553	71	3·44264	16	3·44963	61	3·45652
27	3·43569	72	3·44279	17	3·44979	62	3·45667
28	3·43584	73	3·44295	18	3·44994	63	3·45682
29	3·43600	74	3·44311	19	3·45010	64	3·45697
30	3·43616	75	3·44326	20	3·45025	65	3·45712
31	3·43632	76	3·44342	21	3·45040	66	3·45728
32	3·43648	77	3·44358	22	3·45056	67	3·45743
33	3·43664	78	3·44373	23	3·45071	68	3·45758
34	3·43680	79	3·44389	24	3·45086	69	3·45773
35	3·43696	80	3·44404	25	3·45102	70	3·45788
36	3·43712	81	3·44420	26	3·45117	71	3·45803
37	3·43727	82	3·44436	27	3·45133	72	3·45818
38	3·43743	83	3·44451	28	3·45148	73	3·45834
39	3·43749	84	3·44467	29	3·45163	74	3·45849
40	3·43775	85	3·44483	30	3·45179	75	3·45864
41	3·43791	86	3·44498	31	3·45194	76	3·45879
42	3·43807	87	3·44514	32	3·45209	77	3·45894
43	3·43823	88	3·44529	33	3·45225	78	3·45909
44	3·43838	89	3·44545	34	3·45240	79	3·45924
45	3·43854	90	3·44560	35	3·45255	80	3·45939

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
2881	3.45954	2926	3.46627	2971	3.47290	3016	3.47943
82	3.45969	27	3.46642	72	3.47305	17	3.47958
83	3.45984	28	3.46657	73	3.47319	18	3.47972
84	3.46000	29	3.46672	74	3.47334	19	3.47986
85	3.46015	30	3.46687	75	3.47349	20	3.48001
86	3.46030	31	3.46702	76	3.47363	21	3.48015
87	3.46045	32	3.46716	77	3.47378	22	3.48029
88	3.46060	33	3.46731	78	3.47392	23	3.48044
89	3.46075	34	3.46746	79	3.47407	24	3.48058
90	3.46090	35	3.46761	80	3.47422	25	3.48073
91	3.46105	36	3.46776	81	3.47436	26	3.48087
92	3.46120	37	3.46790	82	3.47451	27	3.48101
93	3.46135	38	3.46805	83	3.47465	28	3.48116
94	3.46150	39	3.46820	84	3.47480	29	3.48130
95	3.46165	40	3.46825	85	3.47494	30	3.48144
96	3.46180	41	3.46850	86	3.47509	31	3.48159
97	3.46195	42	3.46864	87	3.47524	32	3.48173
98	3.46210	43	3.46879	88	3.47538	33	3.48187
99	3.46225	44	3.46894	89	3.47553	34	3.48202
2900	3.46240	45	3.46909	90	3.47567	35	3.48216
2901	3.46255	46	3.46923	91	3.47582	36	3.48230
02	3.46270	47	3.46938	92	3.47596	37	3.48244
03	3.46285	48	3.46953	93	3.47611	38	3.48259
04	3.46300	49	3.46967	94	3.47625	39	3.48273
05	3.46315	50	3.46982	95	3.47640	40	3.48287
06	3.46330	51	3.46997	96	3.47654	41	3.48302
07	3.46345	52	3.47012	97	3.47669	42	3.48316
08	3.46360	53	3.47026	98	3.47683	43	3.48330
09	3.46374	54	3.47041	99	3.47698	44	3.48344
10	3.46389	55	3.47056	3000	3.47712	45	3.48359
11	3.46404	56	3.47070	3001	3.47727	46	3.48373
12	3.46416	57	3.47085	02	3.47741	47	3.48387
13	3.46434	58	3.47100	03	3.47756	48	3.48402
14	3.46449	59	3.47115	04	3.47770	49	3.48416
15	3.46464	60	3.47129	05	3.47784	50	3.48430
16	3.46479	61	3.47144	06	3.47799	51	3.48444
17	3.46494	62	3.47159	07	3.47813	52	3.48458
18	3.46509	63	3.47173	08	3.47828	53	3.48473
19	3.46523	64	3.47188	09	3.47842	54	3.48487
20	3.46538	65	3.47202	10	3.47857	55	3.48501
21	3.46553	66	3.47217	11	3.47871	56	3.48515
22	3.46568	67	3.47232	12	3.47886	57	3.48530
23	3.46583	68	3.47246	13	3.47900	58	3.48544
24	3.46598	69	3.47261	14	3.47914	59	3.48558
25	3.46613	70	3.47276	15	3.47929	60	3.48572

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
3061	3·48586	3106	3·49220	3151	3·49845	3196	3·50461
62	3·48601	07	3·49234	52	3·49859	97	3·50474
63	3·48615	08	3·49248	53	3·49872	98	3·50488
64	3·48629	09	3·49262	54	3·49886	99	3·50501
65	3·48643	10	3·49276	55	3·49900	3200	3·50515
66	3·48657	11	3·49290	56	3·49914	3201	3·50529
67	3·48671	12	3·49304	57	3·49927	02	3·50542
68	3·48686	13	3·49318	58	3·49941	03	3·50556
69	3·48700	14	3·49332	59	3·49955	04	3·50569
70	3·48714	15	3·49346	60	3·49969	05	3·50583
71	3·48728	16	3·49360	61	3·49982	06	3·50596
72	3·48742	17	3·49374	62	3·49996	07	3·50610
73	3·48756	18	3·49388	63	3·50010	08	3·50623
74	3·48770	19	3·49402	64	3·50024	09	3·50637
75	3·48785	20	3·49415	65	3·50037	10	3·50651
76	3·48799	21	3·49429	66	3·50051	11	3·50664
77	3·48813	22	3·49443	67	3·50065	12	3·50678
78	3·48827	23	3·49457	68	3·50079	13	3·50691
79	3·48841	24	3·49471	69	3·50092	14	3·50705
80	3·48855	25	3·49485	70	3·50106	15	3·50718
81	3·48869	26	3·49499	71	3·50120	16	3·50732
82	3·48883	27	3·49513	72	3·50133	17	3·50745
83	3·48897	28	3·49527	73	3·50147	18	3·50759
84	3·48911	29	3·49541	74	3·50161	19	3·50772
85	3·48926	30	3·49554	75	3·50174	20	3·50786
86	3·48940	31	3·49568	76	3·50188	21	3·50799
87	3·48954	32	3·49582	77	3·50202	22	3·50813
88	3·48968	33	3·49596	78	3·50215	23	3·50826
89	3·48982	34	3·49610	79	3·50229	24	3·50840
90	3·48996	35	3·49624	80	3·50243	25	3·50853
91	3·49010	36	3·49638	81	3·50256	26	3·50866
92	3·49024	37	3·49651	82	3·50270	27	3·50880
93	3·49038	38	3·49665	83	3·50284	28	3·50893
94	3·49052	39	3·49679	84	3·50297	29	3·50907
95	3·49066	40	3·49693	85	3·50311	30	3·50920
96	3·49080	41	3·49707	86	3·50325	31	3·50934
97	3·49094	42	3·49721	87	3·50338	32	3·50947
98	3·49108	43	3·49734	88	3·50352	33	3·50961
99	3·49122	44	3·49748	89	3·50365	34	3·50974
3100	3·49136	45	3·49762	90	3·50379	35	3·50987
3101	3·49150	46	3·49776	91	3·50393	36	3·51001
02	3·49164	47	3·49790	92	3·50406	37	3·51014
03	3·49178	48	3·49803	93	3·50420	38	3·51028
04	3·49192	49	3·49817	94	3·50432	39	3·51041
05	3·49206	50	3·49831	95	3·50447	40	3·51055

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
3241	3.51068	3286	3.51667	3331	3.52257	3376	3.52840
42	3.51081	87	3.51680	32	3.52271	77	3.52853
43	3.51095	88	3.51693	33	3.52284	78	3.52866
44	3.51108	89	3.51706	34	3.52297	79	3.52879
45	3.51121	90	3.51720	35	3.52310	80	3.52892
46	3.51135	91	3.51733	36	3.52323	81	3.52905
47	3.51148	92	3.51746	37	3.52336	82	3.52917
48	3.51162	93	3.51759	38	3.52349	83	3.52930
49	3.51175	94	3.51772	39	3.52362	84	3.52943
50	3.51188	95	3.51786	40	3.52375	85	3.52956
51	3.51202	96	3.51799	41	3.52388	86	3.52969
52	3.51215	97	3.51812	42	3.52401	87	3.52982
53	3.51228	98	3.51825	43	3.52414	88	3.52994
54	3.51242	99	3.51838	44	3.52427	89	3.53007
55	3.51255	3300	3.51851	45	3.52440	90	3.53020
56	3.51268	3301	3.51865	46	3.52453	91	3.53033
57	3.51282	02	3.51878	47	3.52466	92	3.53046
58	3.51295	03	3.51891	48	3.52479	93	3.53058
59	3.51308	04	3.51904	49	3.52492	94	3.53071
60	3.51322	05	3.51917	50	3.52504	95	3.53084
61	3.51335	06	3.51930	51	3.52517	96	3.53097
62	3.51348	07	3.51943	52	3.52530	97	3.53110
63	3.51362	08	3.51957	53	3.52543	98	3.53122
64	3.51375	09	3.51970	54	3.52556	99	3.53135
65	3.51388	10	3.51983	55	3.52569	3400	3.53148
66	3.51402	11	3.51996	56	3.52582	3401	3.53161
67	3.51415	12	3.52009	57	3.52595	02	3.53173
68	3.51428	13	3.52022	58	3.52608	03	3.53186
69	3.51441	14	3.52035	59	3.52621	04	3.53199
70	3.51455	15	3.52048	60	3.52634	05	3.53212
71	3.51468	16	3.52061	61	3.52647	06	3.53224
72	3.51481	17	3.52075	62	3.52660	07	3.53237
73	3.51495	18	3.52088	63	3.52673	08	3.53250
74	3.51508	19	3.52101	64	3.52686	09	3.53263
75	3.51521	20	3.52114	65	3.52699	10	3.52275
76	3.51534	21	3.52127	66	3.52711	11	3.53288
77	3.51548	22	3.52140	67	3.52724	12	3.53301
78	3.51561	23	3.52153	68	3.52737	13	3.53314
79	3.51574	24	3.52166	69	3.52750	14	3.53326
80	3.51587	25	3.52179	70	3.52763	15	3.53339
81	3.51601	26	3.52192	71	3.52776	16	3.53352
82	3.51614	27	3.52205	72	3.52789	17	3.53365
83	3.51627	28	3.52218	73	3.52802	18	3.53377
84	3.51640	29	3.52231	74	3.52815	19	3.53390
85	3.51654	30	3.52244	75	3.52827	20	3.53403

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
3421	3.53415	3466	3.53983	3511	3.54543	3556	3.55096
22	3.53428	67	3.53995	12	3.54555	57	3.55108
23	3.53441	68	3.54008	13	3.54568	58	3.55121
24	3.53453	69	3.54020	14	3.54590	59	3.55133
25	3.53466	70	3.54033	15	3.54593	60	3.55145
26	3.53479	71	3.54045	16	3.54605	61	3.55157
27	3.53491	72	3.54058	17	3.54617	62	3.55169
28	3.53504	73	3.54070	18	3.54630	63	3.55182
29	3.53517	74	3.54083	19	3.54642	64	3.55194
30	3.53529	75	3.54095	20	3.54654	65	3.55206
31	3.53542	76	3.54108	21	3.54667	66	3.55218
32	3.53555	77	3.54120	22	3.54679	67	3.55230
33	3.53567	78	3.54133	23	3.54691	68	3.55242
34	3.53580	79	3.54145	24	3.54704	69	3.55255
35	3.53593	80	3.54158	25	3.54716	70	3.55267
36	3.53605	81	3.54170	26	3.54728	71	3.55279
37	3.53618	82	3.54183	27	3.54741	72	3.55291
38	3.53631	83	3.54195	28	3.54753	73	3.55303
39	3.53643	84	3.54208	29	3.54765	74	3.55315
40	3.53656	85	3.54220	30	3.54777	75	3.55328
41	3.53668	86	3.54233	31	3.54790	76	3.55340
42	3.53681	87	3.54245	32	3.54802	77	3.55352
43	3.53694	88	3.54258	33	3.54814	78	3.55364
44	3.53706	89	3.54270	34	3.54827	79	3.55276
45	3.53719	90	3.54283	35	3.54839	80	3.55388
46	3.53732	91	3.54295	36	3.54851	81	3.55400
47	3.53744	92	3.54307	37	3.54864	82	3.55413
48	3.53757	93	3.54320	38	3.54876	83	3.55425
49	3.53769	94	3.54332	39	3.54888	84	3.55437
50	3.53782	95	3.54345	40	3.54900	81	3.55449
51	3.53795	96	3.54357	41	3.54913	86	3.55461
52	3.53807	97	3.54370	42	3.54925	87	3.55473
53	3.53820	98	3.54382	43	3.54937	88	3.55485
54	3.53832	99	3.54394	44	3.54949	89	3.55497
55	3.53845	3500	3.54407	45	3.54962	90	3.55509
56	3.53857	3501	3.54419	46	3.54974	91	3.55522
57	3.53870	02	3.54432	47	3.54986	92	3.55534
58	3.53883	03	3.54444	48	3.54998	93	3.55546
59	3.53895	04	3.54456	49	3.55011	94	3.55558
60	3.53908	05	3.54469	50	3.55023	95	3.55570
61	3.53920	06	3.54481	51	3.55035	96	3.55582
62	3.53933	07	3.54494	52	3.55047	97	3.55594
63	3.53945	08	3.54506	53	3.55060	98	3.55606
64	3.53958	09	3.54518	54	3.55072	99	3.55618
65	3.53970	10	3.54531	55	3.55084	3600	3.55630

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3601	3.55642	3646	3.56182	3691	3.56714	3736	3.57241
02	3.55654	47	3.56194	92	3.56726	37	3.57252
03	3.55666	48	3.56205	93	3.56738	38	3.57264
04	3.55678	49	3.56217	94	3.56750	39	3.57276
05	3.55691	50	3.56229	95	3.56761	40	3.57287
06	3.55703	51	3.56241	96	3.56773	41	3.57299
07	3.55715	52	3.56253	97	3.56785	42	3.57310
08	3.55727	53	3.56265	98	3.56797	43	3.57322
09	3.55739	54	3.56277	99	3.56808	44	3.57334
10	3.55751	55	3.56289	3700	3.56820	45	3.57345
11	3.55763	56	3.56301	3701	3.56832	46	3.57357
12	3.55775	57	3.56313	02	3.56844	47	3.57368
13	3.55787	58	3.56324	03	3.56855	48	3.57380
14	3.55799	59	3.56336	04	3.56867	49	3.57392
15	3.55811	60	3.56348	05	3.56879	50	3.57403
16	3.55[illegible]3	61	3.56360	06	3.56891	51	3.57415
17	3.55835	62	3.56372	07	3.56902	52	3.57426
18	3.55847	63	3.56384	08	3.56914	53	3.57438
19	3.55859	64	3.56396	09	3.56926	54	3.57449
20	3.55871	65	3.56407	10	3.56937	55	3.57461
21	3.55883	66	3.56419	11	3.56949	56	3.57473
22	3.55895	67	3.56431	12	3.56961	57	3.57484
23	3.55907	68	3.56443	13	3.56972	58	3.57496
24	3.55919	69	3.56455	14	3.56984	59	3.57507
25	3.55931	70	3.56467	15	3.56996	60	3.57519
26	3.55943	71	3.56478	16	3.57008	61	3.57530
27	3.55955	72	3.56490	17	3.57019	62	3.57542
28	3.55967	73	3.56502	18	3.57031	63	3.57553
29	3.55979	74	3.56514	19	3.57043	64	3.57565
30	3.55991	75	3.56526	20	3.57054	65	3.57577
31	3.56003	76	3.56538	21	3.57066	66	3.57588
32	3.56015	77	3.56549	22	3.57078	67	3.57600
33	3.56026	78	3.56561	23	3.57089	68	3.57611
34	3.56038	79	3.56573	24	3.57101	69	3.57623
35	3.56050	80	3.56585	25	3.57113	70	3.57634
36	3.56062	81	3.56597	26	3.57124	71	3.57646
37	3.56074	82	3.56608	27	3.57136	72	3.57657
38	3.56086	83	3.56620	28	3.57148	73	3.57669
39	3.56098	84	3.56632	29	3.57159	74	3.57680
40	3.56110	85	3.56644	30	3.57171	75	3.57692
41	3.56122	86	3.56656	31	3.57183	76	3.57703
42	3.56134	87	3.56667	32	3.57194	77	3.57715
43	3.56146	88	3.56679	33	3.57206	78	3.57726
44	3.56158	89	3.56691	34	3.57217	79	3.57738
45	3.56170	90	3.56703	35	3.57229	80	3.57749

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
3781	3.57761	3826	3.58275	3871	3.58782	3916	3.59284
82	3.57772	27	3.58286	72	3.58794	17	3.59295
83	3.57784	28	3.58297	73	3.58805	18	3.59306
84	3.57795	29	3.58309	74	3.58816	19	3.59318
85	3.57807	30	3.58320	75	3.58827	20	3.59329
86	3.57818	31	3.58331	76	3.58838	21	3.59340
87	3.57830	32	3.58343	77	3.58850	22	3.59351
88	3.57841	33	3.58354	78	3.58861	23	3.59362
89	3.57852	34	3.58365	79	3.58872	24	3.59373
90	3.57864	35	3.58377	80	3.58883	25	3.59384
91	3.57875	36	3.58388	81	3.58894	26	3.59395
92	3.57887	37	3.58399	82	3.58906	27	3.59406
93	3.57898	38	3.58411	83	3.58917	28	3.59417
94	3.57910	39	3.58422	84	3.58928	29	3.59428
95	3.57921	40	3.58433	85	3.58939	30	3.59439
96	3.57933	41	3.58444	86	3.58950	31	3.59450
97	3.57944	42	3.58456	87	3.58961	32	3.59461
98	3.57956	43	3.58467	88	3.58973	33	3.59472
99	3.57967	44	3.58473	89	3.58984	34	3.59483
3800	3.57978	45	3.58490	90	3.58995	35	3.59494
3801	3.57990	46	3.58501	91	3.59006	36	3 59506
02	3.58001	47	3.58512	92	3.59017	37	3.59517
03	3.58013	48	3.58524	93	3.59028	38	3.59528
04	3.58024	49	3.58535	94	3.59040	39	3.59539
05	3.58035	50	3.58546	95	3.59051	40	3.59550
06	3.58047	51	3.58557	96	3 59062	41	2.59561
07	3.58058	52	3.58569	97	3.59073	42	3.59572
08	3.58070	53	3.58580	98	3.59084	43	3.59583
09	3.58081	54	3.58591	99	3.59095	44	3.59594
10	3.58093	55	3.58602	3900	3.59106	45	3.59605
11	3.58104	56	3.58614	3901	3.59118	46	3.59616
12	3.58115	57	3.58625	02	3.59129	47	3.59627
13	3.58127	58	3.58636	03	3.59140	48	3.59638
14	3.58138	59	3.58647	04	3.59151	49	3.59649
15	3.58149	60	3.58659	05	3.59162	50	3.59660
16	3.58161	61	3.58670	06	3.59173	51	3.59671
17	3.58172	62	3.58681	07	3.59184	52	3.59682
18	3.58184	63	3.58692	08	3.59195	53	3.59693
19	3.58195	64	3.58704	09	3.59207	54	3.59704
20	3.58206	65	3.58715	10	3.59218	55	3.59715
21	3.58218	66	3.58726	11	3.59229	56	3.59726
22	3.58229	67	3.58737	12	3.59240	57	3.59737
23	3.58240	68	3.58749	13	3.59251	58	3.59748
24	3.58252	69	3.58760	14	3.59262	59	3.59759
25	3.58263	70	3.58771	15	3.59273	60	3 59770

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
3961	3.59780	4006	3.60271	4051	3.60756	4096	3.61256
62	3.59791	07	3.60282	52	3.60767	97	3.61247
63	3.59802	08	3.60293	53	3.60778	98	3.61257
64	3.59813	09	3.60304	54	3.60788	99	3.61268
65	3.59824	10	3.60314	55	3.60799	4100	3.61278
66	3.59835	11	3.60325	56	3.60810	4101	3.61289
67	3.59846	12	3.60336	57	3.60821	02	3.61300
68	3.59857	13	3.60347	58	3.60831	03	3.61310
69	3.59868	14	3.60358	59	3.60842	04	3.61321
70	3.59879	15	3.60369	60	3.60853	05	3.61331
71	3.59890	16	3.60379	61	3.60863	06	3.61342
72	3.59901	17	3.60390	62	3.60874	07	3.61352
73	3.59912	18	3.60401	63	3.60885	08	3.61363
74	3.59923	19	3.60412	64	3.60895	09	3.61374
75	3.59934	20	3.60423	65	3.60906	10	3.61384
76	3.59945	21	3.60433	66	3.60917	11	3.61395
77	3.59956	22	3.60444	67	3.60927	12	3.61405
78	3.59966	23	3.60455	68	3.60938	13	3.61416
79	3.59977	24	3.60466	69	3.60946	14	3.61426
80	3.59988	25	3.60477	70	3.60959	15	3.61437
81	3.59999	26	3.60487	71	3.60970	16	3.61448
82	3.60010	27	3.60498	72	3.60981	17	3.61458
83	3.60021	28	4.60509	73	3.60991	18	3.61469
84	3.60032	29	3.60520	74	3.61002	19	3.61479
85	3.60043	30	3.60531	75	3.61013	20	3.61490
86	3.60054	31	3.60541	76	3.61023	21	3.61500
87	3.60065	32	3.60552	77	3.61034	22	3.61511
88	3.60076	33	3.60563	78	3.61045	23	3.61521
89	3.60086	34	3.60574	79	3.61055	24	3.61532
90	3.60097	35	3.60584	80	3.61066	25	3.61542
91	3.60108	36	3.60595	81	3.61077	26	3.61553
92	3.60119	37	3.60606	82	3.61087	27	3.61563
93	3.60130	38	3.60617	83	3.61098	28	3.61574
94	3.60141	39	3.60627	84	3.61109	29	3.61584
95	3.60152	40	3.60638	85	3.61119	30	3.61595
96	3.60163	41	3.60649	86	3.61130	31	3.61606
97	3.60173	42	3.60660	87	3.61140	32	3.61616
98	3.60184	43	3.60670	88	3.61151	33	3.61627
99	3.60195	44	3.60681	89	3.61162	34	3.61637
4000	3.60206	45	3.60692	90	3.61172	35	3.61648
4001	3.60217	46	3.60703	91	3.61183	36	3.61658
02	3.60228	47	3.60713	92	3.61194	37	3.61669
03	3.60239	48	3.60724	93	3.61204	38	3.61679
04	3.60249	49	3.60735	94	3.61215	39	3.61690
05	3.60260	50	3.60746	95	3.61225	40	3.61700

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
4141	3.61711	4186	3.62180	4231	3.62644	4276	3.63104
42	3.61721	87	3.62190	32	3.62655	77	3.63114
43	3.61731	88	3.62201	33	3.62665	78	3.63124
44	3.61742	89	3.62211	34	3.62675	79	3.63134
45	3.61752	90	3.62221	35	3.62685	80	3.63144
46	3.61763	91	3.62232	36	3.62696	81	3.63155
47	3.61773	92	3.62242	37	3.62706	82	3.63165
48	3.61784	93	3.62252	38	3.62716	83	3.63175
49	3.61794	94	3.62263	39	3.62726	84	3.63185
50	3.61805	95	3.62273	40	3.62737	85	3.63195
51	3.61815	96	3.62284	41	3.62747	86	3.63205
52	3.61826	97	3.62294	42	3.62757	87	3.63215
53	3.61836	98	3.62304	43	3.62767	88	3.63225
54	3.61847	99	3.62315	44	3.62778	89	3.63236
55	3.61857	4200	3.62325	45	3.62788	90	3.63246
56	3.61868	4201	3.62335	46	3.62798	91	3.63256
57	3.61878	02	3.62346	47	3.62808	92	3.63266
58	3.61888	03	3.62356	48	3.62818	93	3.63276
59	3.61899	04	3.62366	49	3.62829	94	3.63286
60	3.61909	05	3.62377	50	3.62839	95	3.63296
61	3.61920	06	3.62387	51	3.62849	96	3.63396
62	3.61930	07	3.62397	52	3.62859	97	3.63317
63	3.61941	08	3.62408	53	3.62870	98	3.63327
64	3.61951	09	3.62418	54	3.62880	99	3.63337
65	3.61962	10	3.62428	55	3.62890	4300	3.63347
66	3.61972	11	3.62439	56	3.62900	4301	3.63357
67	3.61982	12	3.62449	57	3.62910	02	3.63367
68	3.61993	13	3.62459	58	3.62921	03	3.63377
69	3.62003	14	3.62469	59	3.62931	04	3.63387
70	3.62014	15	3.62480	60	3.62941	05	3.63397
71	3.62024	16	3.62490	61	3.62951	06	3.63407
72	3.62034	17	3.62500	62	3.62961	07	3.63417
73	3.62045	18	3.62511	63	3.62972	08	3.63428
74	3.62055	19	3.62521	64	3.62982	09	3.63438
75	3.62066	20	3.62531	65	3.62992	10	3.63448
76	3.62076	21	3.62542	66	3.63002	11	3.63458
77	3.62086	22	3.62552	67	3.63012	12	3.63468
78	3.62097	23	3.62562	68	3.63022	13	3.63478
79	3.62107	24	3.62572	69	3.63033	14	3.63488
80	3.62118	25	3.62583	70	3.63043	15	3.63498
81	3.62128	26	3.62593	71	3.63053	16	3.63508
82	3.62138	27	3.62603	72	3.63063	17	3.63518
83	3.62149	28	3.62614	73	3.63073	18	3.63528
84	3.62159	29	3.62624	74	3.63083	19	3.63538
85	3.62170	30	3.62634	75	3.63094	20	3.63548

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4321	3.63558	4366	3.64008	4411	3.64454	4456	3.64895
22	3.63568	67	3.64018	12	3.64464	57	3.64904
23	3.63579	68	3.64028	13	3.64473	58	3.64914
24	3.63589	69	3.64038	14	3.64483	59	3.64924
25	3.63599	70	3.64048	15	3.64493	60	3.64933
26	3.63609	71	3.64058	16	3.64503	61	3.64943
27	3.63619	72	3.64068	17	3.64513	62	3.64953
28	3.63629	73	3.64078	18	3.64523	63	3.64963
29	3.63639	74	3.64088	19	3.64532	64	3.64972
30	3.63649	75	3.64098	20	3.64542	65	3.64982
31	3.63659	76	3.64108	21	3.64552	66	3.64992
32	3.63669	77	3.64118	22	3.64562	67	3.65002
33	3.63679	78	3.64128	23	3.64572	68	3.65011
34	3.63689	79	3.64137	24	3.64582	69	3.65021
35	3.63699	80	3.64147	25	3.64591	70	3.65031
36	3.63709	81	3.64157	26	3.64601	71	3.65040
37	3.63719	82	3.64167	27	3.64611	72	3.65050
38	3.63729	83	3.64177	28	3.64621	73	3.65060
39	3.63739	84	3.64187	29	3.64631	74	3.65070
40	3.63749	85	3.64197	30	3.64640	75	3.65079
41	3.63759	86	3.64207	31	3.64650	76	3.65089
42	3.63769	87	3.64217	32	3.64660	77	3.65099
43	3.63779	88	3.64227	33	3.64670	78	3.65108
44	3.63789	89	3.64237	34	3.64680	79	3.65118
45	3.63799	90	3.64246	35	3.64689	80	3.65128
46	3.63809	91	3.64256	36	3.64699	81	3.65137
47	3.63819	92	3.64266	37	3.64709	82	3.65147
48	3.63829	93	3.64276	38	3.64719	83	3.65157
49	[illegible]	94	3.64286	39	3.64729	84	3.65167
50	[illegible]	95	3.64296	40	3.64738	85	3.65176
51	[illegible]	96	3.64306	41	3.64748	86	3.65186
52	3.63869	97	3.64316	42	3.64758	87	3.65196
53	3.63879	98	3.64326	43	3.64768	88	3.65205
54	3.63889	99	3.64335	44	3.64777	89	3.65215
55	3.63899	4400	3.64345	45	3.64787	90	3.65225
56	3.63909	4401	3.64355	46	3.64797	91	3.65234
57	3.63919	02	3.64365	47	3.64807	92	3.65244
58	3.63929	03	3.64375	48	3.64816	93	3.65254
59	3.63939	04	3.64385	49	3.64826	94	3.65263
60	3.63949	05	3.64395	50	3.64836	95	3.65273
61	3.63959	06	3.64404	51	3.64846	96	3.65283
62	3.63969	07	3.64414	52	3.64855	97	3.65292
63	3.63979	08	3.64424	53	3.64865	98	3.65302
64	3.63989	09	3.64434	54	3.64875	99	3.65312
65	3.63998	10	3.64444	55	3.64885	4500	3.65321

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
4501	3.65331	4546	3.65763	4591	3.66191	4636	3.66614
02	3.65341	47	3.65773	92	3.66200	37	3.66624
03	3.65350	48	3.65782	93	3.66210	38	3.66633
04	3.65360	49	3.65792	94	3.66219	39	3.66642
05	3.65369	50	3.65801	95	3.66229	40	3.66652
06	3.65379	51	3.65811	96	3.66238	41	3.66661
07	3.65389	52	3.65820	97	3.66247	42	3.66671
08	3.65398	53	3.65830	98	3.66257	43	3.66680
09	3.65408	54	3.65839	99	3.66266	44	3.66689
10	3.65418	55	3.65849	4600	3.66276	45	3.66699
11	3.65427	56	3.65858	4601	3.66285	46	3.66708
12	3.65437	57	3.65868	02	3.66295	47	3.66717
13	3.65447	58	3.65877	03	3.66304	48	3.66727
14	3.65456	59	3.65887	04	3.66314	49	3.66736
15	3.65466	60	3.65896	05	3.66323	50	3.66745
16	3.65475	61	3.65906	06	3.66332	51	3.66755
17	3.65485	62	3.65916	07	3.66342	52	3.66764
18	3.65495	63	3.65925	08	3.66351	53	3.66773
19	3.65504	64	3.65935	09	3.66361	54	3.66783
20	3.65514	65	3.65944	10	3.66370	55	3.66792
21	3.65523	66	3.65954	11	3.66380	56	3.66801
22	3.65533	67	3.65963	12	3.66389	57	3.66811
23	3.65543	68	3.65973	13	3.66398	58	3.66820
24	3.65552	69	3.65982	14	3.66408	59	3.66829
25	3.65562	70	3.65992	15	3.66417	60	3.66839
26	3.65571	71	3.66001	16	3.66427	61	3.66848
27	3.65581	72	3.66011	17	3.66436	62	3.66857
28	3.65591	73	3.66020	18	3.66445	63	3.66867
29	3.65600	74	3.66030	19	3.66455	64	3.66876
30	3.65610	75	3.66039	20	3.66464	65	3.66885
31	3.65619	76	3.66049	21	3.66474	66	3.66894
32	3.65629	77	3.66058	22	3.66483	67	3.66904
33	3.65639	78	3.66068	23	3.66492	68	3.66913
34	3.65648	79	3.66077	24	3.66502	69	3.66922
35	3.65658	80	3.66087	25	3.66511	70	3.66932
36	3.65667	81	3.66096	26	3.66521	71	3.66941
37	3.65677	82	3.66106	27	3.66530	72	3.66950
38	3.65686	83	3.66115	28	3.66539	73	3.66960
39	3.65696	84	3.66124	29	3.66549	74	3.66969
40	3.65706	85	3.66134	30	3.66558	75	3.66978
41	3.65715	86	3.66143	31	3.66567	76	3.66987
42	3.65725	87	3.66153	32	3.66577	77	3.66997
43	3.65734	88	3.66162	33	3.66586	78	3.67006
44	3.65744	89	3.66172	34	3.66596	79	3.67015
45	3.65753	90	3.66181	35	3.66605	80	3.67025

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
4681	3.67034	4726	3.67449	4771	3.67861	4816	3.68269
82	3.67043	27	3.67459	72	3.67870	17	3.68278
83	3.67052	28	3.67468	73	3.67879	18	3.68287
84	3.67062	29	3.67477	74	3.67888	19	3.68296
85	3.67071	30	3.67486	75	3.67897	20	3.68305
86	3.67080	31	3.67495	76	3.67906	21	3.68314
87	3.67090	32	3.67504	77	3.67916	22	3.68323
88	3.67099	33	3.67514	78	3.67925	23	3.68332
89	3.67108	34	3.67523	79	3.67934	24	3.68341
90	3.67117	35	3.67532	80	3.67943	25	3.68350
91	3.67127	36	3.67541	81	3.67952	26	3.68359
92	3.67136	37	3.67550	82	3.67961	27	3.68368
93	3.67145	38	3.67560	83	3.67970	28	3.68377
94	3.67154	39	3.67569	84	3.67979	29	3.68386
95	3.67104	40	3.67578	85	3.67988	30	3.68395
96	3.67173	41	3.67587	86	3.67997	31	3.68404
97	3.67182	42	3.67596	87	3.68006	32	3.68413
98	3.67191	43	3.67605	88	3.68015	33	3.68422
99	3.67201	44	3.67614	89	3.68024	34	3.68431
4700	3.67210	45	3.67624	90	3.68034	35	3.68440
4701	3.67219	46	3.67633	91	3.68043	36	3.68449
02	3.67228	47	3.67642	92	3.68052	37	3.68458
03	3.67238	48	3.67651	93	3.68061	38	3.68467
04	3.67247	49	3.67660	94	3.68070	39	3.68476
05	3.67256	50	3.67669	95	3.68079	40	3.68485
06	3.67265	51	3.67079	96	3.68088	41	3.68494
07	3.67274	52	3.67688	97	3.68097	42	3.68502
08	3.67284	53	3.67697	98	3.68106	43	3.68511
09	3.67293	54	3.67706	99	3.68115	44	3.68520
10	3.67302	55	3.67715	4800	3.68124	45	3.68529
11	3.67311	56	3.67724	4801	3.68133	46	3.68538
12	3.67321	57	3.67733	02	3.68142	47	3.68547
13	3.67330	58	3.67742	03	3.68151	48	3.68556
14	3.67339	59	3.67752	04	3.68160	49	3.68565
15	3.67348	60	3.67761	05	3.68169	50	3.68574
16	3.67357	61	3.67770	06	3.68178	51	3.68583
17	3.67367	62	3.67779	07	3.68187	52	3.68592
18	3.67376	63	3.67788	08	3.68196	53	3.68601
19	3.67385	64	3.67797	09	3.68205	54	3.68610
20	3.67394	65	3.37806	10	3.68215	55	3.68610
21	3.67403	66	3.67815	11	3.68224	56	3.68628
22	3.67413	67	3.67825	12	3.68233	57	3.68637
23	3.67422	68	3.67834	13	3.68242	58	3.68646
24	3.67431	69	3.67843	14	3.68251	59	3.68655
25	3.67440	70	3.67852	15	3.68260	60	3.68664

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
4861	3.68673	4906	3.69073	4951	3.69469	4996	3.69862
62	3.68681	07	3.69082	52	3.69478	97	3.69871
63	3.68690	08	3.69090	53	3.69487	98	3.69880
64	3.68699	09	3.69099	54	3.69496	99	3.69888
65	3.68708	10	3.69108	55	3.69504	5000	3.69897
66	3.68717	11	3.69117	56	3.09513	5001	3.69906
67	3.68726	12	3.69126	57	3.69522	02	3.69914
68	3.68735	13	3.69135	58	3.69531	03	3.69923
69	3.68744	14	3.69144	59	3.69539	04	3.69932
70	3.68753	15	3.69152	60	3.69548	05	3.69940
71	3.68762	16	3.69161	61	3.69557	06	3.69949
72	3.68771	17	3.69170	62	3.69566	07	3.69958
73	3.68780	18	3.69179	63	3.69574	08	3.69966
74	3.68789	19	3.69188	64	3.69583	09	3.69975
75	3.68797	20	3.69197	65	3.69592	10	3.69984
76	3.68806	21	3.69205	66	3.69601	11	3.69992
77	3.68815	22	3.69214	67	3.69609	12	3.70001
78	3.68824	23	3.69223	68	3.69618	13	3.70010
79	3.68833	24	3.69232	69	3.69627	14	3.70018
80	3.68842	25	3.69241	70	3.69636	15	2.70027
81	3.68851	26	3.69249	71	3.69644	16	3.70036
82	3.68860	27	3.69258	72	3.69653	17	3.70044
83	3.68869	28	3.69267	73	3.69602	18	3.70053
84	3.68878	29	3.69276	74	3.69671	19	3.70062
85	3.68886	30	3.69285	75	3.69679	20	3.70070
86	2.68895	31	3.69294	76	3.69688	21	3.70079
87	3.68904	32	3.69302	77	3.69697	22	3.70088
88	3.68913	33	3.69311	78	3.69705	23	3.70096
89	3.68922	34	3.69320	79	3.69714	24	3.70105
90	3.68931	35	3.69329	80	3.69723	25	3.70114
91	3.68940	36	3.69338	81	3.69732	26	3.70122
92	3.68649	37	3.69346	82	3.69740	27	3.70131
93	3.68958	38	3.69355	83	3.69749	28	3.70140
94	3.68966	39	3.69364	84	3.69758	29	3.70148
95	3.68975	40	3.69373	85	3.69767	30	3.70157
96	3.68984	41	3.69381	86	3.69775	31	3.70165
97	3.68993	42	3.69390	87	3.69784	32	3.70174
98	3.69002	43	3.69399	88	3.69793	33	3.70183
99	3.69011	44	3.69408	89	3.69801	34	3.70191
4900	3.69020	45	3.69417	90	3.69810	35	3.70200
4901	3.69028	46	3.69425	91	3.69819	36	3.70209
02	3.69037	47	3.69434	92	3.69827	37	3.70217
03	3.69046	48	3.69443	93	3.69836	38	3.70226
04	3.69055	49	3.69452	94	3.69845	39	3.70234
05	3.69064	50	3.69461	95	3.69254	40	3.70243

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
41	3.70252	5086	3.70638	5131	3.71020	5176	3.71399
42	3.70260	87	3.70646	32	3.71028	77	3.71408
43	3.70269	88	3.70655	33	3.71037	78	3.71416
44	3.70278	89	3.70663	34	3.71046	79	3.71425
45	3.70286	90	3.70672	35	3.71054	80	3.71433
46	3.70295	91	3.70680	36	3.71063	81	3.71441
47	3.70303	92	3.70689	37	3.71071	82	3.71450
48	3.70312	93	3.70697	38	3.71079	83	3.71458
49	3.70321	94	3.70706	39	3.71088	84	3.71467
50	3.70329	95	3.70714	40	3.71096	85	3.71475
51	3.70338	96	3.70723	41	3.71105	86	3.71483
52	3.70346	97	3.70731	42	3.71113	87	3.71492
53	3.70355	98	3.70740	43	3.71122	88	3.71500
54	3.70364	99	3.70749	44	3.71130	89	3.71508
55	3.70372	5100	3.70757	45	3.71139	90	3.71517
56	3.70381	5101	3.70766	46	3.71147	91	3.71525
57	3.70389	02	3.70774	47	3.71155	92	3.71533
58	3.70398	03	3.70783	48	3.71164	93	3.71542
59	3.70406	04	3.70791	49	3.71172	94	3.71550
60	3.70415	05	3.70800	50	3.71181	95	3.71559
61	3.70424	06	3.70808	51	3.71189	96	3.71567
62	3.70432	07	3.70817	52	3.71198	97	3.71575
63	3.70441	08	3.70825	53	3.71206	98	3.71584
64	3.70449	09	3.70834	54	3.71214	99	3.71592
65	3.70458	10	3.70842	55	3.71223	5200	3.71600
66	3.70466	11	3.70851	56	3.71231	5201	3.71609
67	3.70475	12	3.70859	57	3.71240	02	3.71617
68	3.70484	13	3.70868	58	3.71248	03	3.71625
69	3.70492	14	3.70876	59	3.71257	04	3.71634
70	3.70501	15	3.70885	60	3.71265	05	3.71642
71	3.70509	16	3.70893	61	3.71273	06	3.71650
72	3.70518	17	3.70902	62	3.71282	07	3.71659
73	3.70526	18	3.70910	63	3.71290	08	3.71667
74	3.70535	19	3.70919	64	3.71299	09	3.71675
75	3.70544	20	3.70927	65	3.71307	10	3.71684
76	3.70552	21	3.70935	66	3.71315	11	3.71692
77	3.70561	22	3.70944	67	3.71324	12	3.71700
78	3.70569	23	3.70952	68	3.71332	13	3.71709
79	3.70578	24	3.70961	69	3.71341	14	3.71717
80	3.70586	25	3.70969	70	3.71349	15	3.71725
81	3.70595	26	3.70978	71	3.71357	16	3.71734
82	3.70603	27	3.70986	72	3.71366	17	3.71742
83	3.70612	28	3.70995	73	3.71374	18	3.71750
84	3.70621	29	3.71003	74	3.71383	19	3.71759
85	3.70629	30	3.71012	75	3.71391	20	3.71767

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5221	3·71775	5266	3·72148	5311	3·72518	5356	3·72884
22	3·71784	67	3·72156	12	3·72526	57	3·72892
23	3·71792	68	3·72165	13	3·72534	58	3·72900
24	3·71800	69	3·72173	14	3·72542	59	3·72908
25	3·71809	70	3·72181	15	3·72550	60	3·72916
26	3·71817	71	3·72189	16	3·72559	61	3·72925
27	3·71825	72	3·72198	17	3·72567	62	3·72933
28	3·71834	73	3·72206	18	3·72575	63	3·72941
29	3·71842	74	3·72214	19	3·72583	64	3·72949
30	3·71850	75	3·72222	20	3·72591	65	3·72957
31	3·71858	76	3·72230	21	3·72599	66	3·72965
32	3·71867	77	3·72239	22	3·72607	67	3·72973
33	3·71875	78	3·72247	23	3·72616	68	3·72981
34	3·71883	79	3·72255	24	3·72624	69	3·72989
35	3·71892	80	3·72263	25	3·72632	70	3·72997
36	3·71900	81	3·72272	26	3·72640	71	3·73006
37	3·71908	82	3·72280	27	3·72648	72	3·73014
38	3·71917	83	3·72288	28	3·72656	73	3·73022
39	3·71925	84	3·72296	29	3·72665	74	3·73030
40	3·71933	85	3·72305	30	3·72673	75	3·73038
41	3·71941	86	3·72313	31	3·72681	76	3·73046
42	3·71950	87	3·72321	32	3·72689	77	3·73054
43	3·71958	88	3·72329	33	3·72697	78	3·73062
44	3·71966	89	3·72337	34	3·72705	79	3·73070
45	3·71975	90	3·72346	35	3·72713	80	3·73078
46	3·71983	91	3·72354	36	3·72722	81	3·73086
47	3·71991	92	3·72362	37	3·72730	82	3·73094
48	3·71999	93	3·72370	38	3·72738	83	3·73102
49	3·72008	94	3·72378	39	3·72746	84	3·73111
50	3·72016	95	3·72387	40	3·72754	85	3·73119
51	3·72024	96	3·72395	41	3·72762	86	3·73127
52	3·72032	97	3·72403	42	3·72770	87	3·73135
53	3·72041	98	3·72411	43	3·72779	88	3·73143
54	3·72049	99	3·72419	44	3·72787	89	3·73151
55	3·72057	5300	3·72428	45	3·72795	90	3·73159
56	3·72066	5301	3·72436	46	3·72803	91	3·73167
57	3·72074	02	3·72444	47	3·72811	92	3·73175
58	3·72082	03	3·72452	48	3·72819	93	3·73183
59	3·72090	04	3·72460	49	3·72827	94	3·73191
60	3·72099	05	3·72469	50	3·72835	95	3·73199
61	3·72107	06	3·72477	51	3·72843	96	3·73207
62	3·72115	07	3·72485	52	3·72852	97	3·73215
63	3·72123	08	3·72491	53	3·72860	98	3·73223
64	3·72132	09	3·72501	54	3·72868	99	3·73231
65	3·72140	10	3·72509	55	3·72876	5400	3·73239

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5401	3.73247	5446	3.73608	5491	3.73965	5536	3.74320
02	3.73255	47	3.73616	92	3.73973	37	3.74327
03	3.73264	48	3.73624	93	3.73981	38	3.74335
04	3.73272	49	3.73632	94	3.73989	39	3.74343
05	3.73280	50	3.73640	95	3.73997	40	3.74351
06	3.73288	51	3.73648	96	3.74005	41	3.74359
07	3.73296	52	3.73656	97	3.74013	42	3.74367
08	3.73304	53	3.73664	98	3.74020	43	3.74374
09	3.73312	54	3.73672	99	3.74028	44	3.74382
10	3.73320	55	3.73679	5500	3.74036	45	3.74390
11	3.73328	56	3.73687	5501	3.74044	46	3.74398
12	3.73336	57	3.73695	02	3.74052	47	3.74406
13	3.73344	58	3.73703	03	3.74060	48	3.74414
14	3.73352	59	3.73711	04	3.74068	49	3.74421
15	3.73360	60	3.73719	05	3.74076	50	3.74429
16	3.73368	61	3.73727	06	3.74084	51	3.74437
17	3.73376	62	3.73735	07	3.74092	52	3.74445
18	3.73384	63	3.73743	08	3.74099	53	3.74453
19	3.73392	64	3.73751	09	3.74107	54	3.74461
20	3.73400	65	3.73759	10	3.74115	55	3.74468
21	3.73408	66	3.73767	11	3.74123	56	3.74476
22	3.73416	67	3.73775	12	3.74131	57	3.74484
23	3.73424	68	3.73783	13	3.74139	58	3.74492
24	3.73432	69	3.73791	14	3.74147	59	3.74500
25	3.73440	70	3.73799	15	3.74155	60	3.74597
26	3.73448	71	3.73807	16	3.74162	61	3.74515
27	3.73456	72	3.73815	17	3.74170	62	3.74523
28	3.73464	73	3.73823	18	3.74178	63	3.74531
29	3.73472	74	3.73830	19	3.74186	64	3.74539
30	3.73480	75	3.73838	20	3.74194	65	3.74547
31	3.73488	76	3.73846	21	3.74202	66	3.74554
32	3.73496	77	3.73854	22	3.74210	67	3.74562
33	3.73504	78	3.73862	23	3.74218	68	3.74570
34	3.73512	79	3.73870	24	3.74225	69	3.74578
35	3.73520	80	3.73878	25	3.74233	70	3.74586
36	3.73528	81	3.73886	26	3.74241	71	3.74593
37	3.73536	82	3.73894	27	3.74249	72	3.74601
38	3.73544	83	3.73902	28	3.74257	73	3.74609
39	3.73552	84	3.73909	29	3.74265	74	3.74617
40	3.73560	85	3.73918	30	3.74273	75	3.74624
41	3.73568	86	3.73926	31	3.74280	76	3.74632
42	3.73576	87	3.73934	32	3.74288	77	3.74640
43	3.73584	88	3.73941	33	3.74296	78	3.74648
44	3.73592	89	3.73949	34	3.74304	79	3.74656
45	3.73600	90	3.73957	35	3.74312	80	3.74663

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5581	3.74671	5626	3.75020	5671	3.75366	5716	3.75709
82	3.74679	27	3.75028	72	3.75374	17	3.75717
83	3.74687	28	3.75035	73	3.75381	18	3.75724
84	3.74695	29	3.75043	74	3.75389	19	3.75732
85	3.74702	30	3.75051	75	3.75397	20	3.75740
86	3.74710	31	3.75059	76	3.75404	21	3.75747
87	3.74718	32	3.75066	77	3.75412	22	3.75755
88	3.74726	33	3.75074	78	3.75420	23	3.75762
89	3.74733	34	3.75082	79	3.75427	24	3.75770
90	3.74741	35	3.75089	80	3.75435	25	3.75778
91	3.74749	36	3.75097	81	3.75442	26	3.75785
92	3.74757	37	3.75105	82	3.75450	27	3.75793
93	3.74764	38	3.75113	83	3.75458	28	3.75800
94	3.74772	39	3.75120	84	3.75465	29	3.75808
95	3.74780	40	3.75128	85	3.75473	30	3.75815
96	3.74788	41	3.75136	86	3.75481	31	3.75823
97	3.74796	42	3.75143	87	3.75488	32	3.75831
98	3.74803	43	3.75151	88	3.75496	33	3.75838
99	3.74811	44	3.75159	89	3.75504	34	3.75846
5600	3.74819	45	3.75166	90	3.75511	35	3.75853
5601	3.74827	46	3.75174	91	3.75519	36	3.75861
02	3.74834	47	3.75182	92	3.75526	37	3.75868
03	3.74842	48	3.75189	93	3.75534	38	3.75876
04	3.74850	49	3.75197	94	3.75542	39	3.75884
05	3.74858	50	3.75205	95	3.75549	40	3.75891
06	3.74865	51	3.75213	96	3.75557	41	3.75899
07	3.74873	52	3.75220	97	3.75565	42	3.75906
08	3.74881	53	3.75228	98	3.75572	43	3.75914
09	3.74889	54	3.75236	99	3.75580	44	3.75921
10	3.74896	55	3.75243	5700	3.75587	45	3.75929
11	3.74904	56	3.75251	5701	3.75595	46	3.75937
12	3.74912	57	3.75259	02	3.75603	47	3.75944
13	3.74920	58	3.75266	03	3.75610	48	3.75952
14	3.74927	59	3.75274	04	3.75618	49	3.75959
15	3.74935	60	3.75282	05	3.75626	50	3.75967
16	3.74943	61	3.75289	06	3.75633	51	3.75974
17	3.74950	62	3.75297	07	3.75641	52	3.75982
18	3.74958	63	3.75305	08	3.75648	53	3.75989
19	3.74966	64	3.75312	09	3.75656	54	3.75997
20	3.74974	65	3.75320	10	3.75664	55	3.76005
21	3.74981	66	3.75328	11	3.75671	56	3.76012
22	3.74989	67	3.75335	12	3.75679	57	3.76020
23	3.74997	68	3.75343	13	3.75686	58	3.76027
24	3.75005	69	3.75351	14	3.75694	59	3.76035
25	3.75012	70	3.75258	15	3.75702	60	3.76042

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
5761	3.76050	5806	3.76388	5851	3.76723	5896	3.77056
62	3.76057	07	3.76395	52	3.76730	97	3.77063
63	3.76065	08	3.76403	53	3.76738	98	3.77070
64	3.76072	09	3.76410	54	3.76745	99	3.77078
65	3.76080	10	3.76418	55	3.76753	5900	3.77085
66	3.76087	11	3.76425	56	3.76760	5901	3.77093
67	3.76095	12	3.76433	57	3.76768	02	3.77100
68	3.76103	13	3.76440	58	3.76775	03	3.77107
69	3.76110	14	3.76448	59	3.76782	04	3.77115
70	3.76118	15	3.76455	60	3.76790	05	3.77122
71	3.76125	16	3.76462	61	3.76797	06	3.77129
72	3.76133	17	3.76470	62	3.76805	07	3.77137
73	3.76140	18	3.76477	63	3.76812	08	3.77144
74	3.76148	19	3.76485	64	3.76819	09	3.77151
75	3.76155	20	3.76492	65	3.76827	10	3.77159
76	3.76163	21	3.76500	66	3.76834	11	3.77166
77	3.76170	22	3.76507	67	3.76842	12	3.77173
78	3.76178	23	3.76515	68	3.76849	13	3.77181
79	3.76185	24	3.76522	69	3.76856	14	3.77188
80	3.76193	25	3.76530	70	3.76864	15	3.77195
81	3.76200	26	3.76537	71	3.76871	16	3.77203
82	3.76208	27	3.76545	72	3.76879	17	3.77210
83	3.76215	28	3.76552	73	3.76886	18	3.77218
84	3.76223	29	3.76559	74	3.76893	19	3.77225
85	3.76230	30	3.76567	75	3.76901	20	3.77232
86	3.76238	31	3.76574	76	3.76908	21	3.77240
87	3.76245	32	3.76582	77	3.76916	22	3.77247
88	3.76253	33	3.76589	78	3.76923	23	3.77254
89	3.76260	34	3.76597	79	3.76930	24	3.77262
90	3.76268	35	3.76604	80	3.76938	25	3.77269
91	3.76275	36	3.76612	81	3.76945	26	3.77276
92	3.76283	37	3.76619	82	3.76953	27	3.77283
93	3.76290	38	3.76626	83	3.76960	28	3.77291
94	3.76298	39	3.76634	84	3.76967	29	3.77298
95	3.76305	40	3.76641	85	3.76975	30	3.77305
96	3.76313	41	3.76649	86	3.76982	31	3.77313
97	3.76320	42	3.76656	87	3.76989	32	3.77320
98	3.76328	43	3.76664	88	3.76997	33	3.77327
99	3.76335	44	3.76671	89	3.77004	34	3.77335
5800	3.76343	45	3.76678	90	3.77012	35	3.77342
5801	3.76350	46	3.76686	91	3.77019	36	3.77349
02	3.76358	47	3.76693	92	3.77026	37	3.77357
03	3.76365	48	3.76701	93	3.77034	38	3.77364
04	3.76373	49	3.76708	94	3.77041	39	3.77371
05	3.76380	50	3.76716	95	3.77048	40	3.77379

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
5941	3·77386	5986	3·77714	6031	3·78039	6076	3·78362
42	3·77393	87	3·77721	32	3·78046	77	3·78369
43	3·77401	88	3·77728	33	3·78053	78	3·78376
44	3·77408	89	3·77735	34	3·78061	79	3·78383
45	3·77415	90	3·77743	35	3·78068	80	3·78390
46	3·77422	91	3·77750	36	3·78075	81	3·78398
47	3·77430	92	3·77757	37	3·78082	82	3·78405
48	3·77437	93	3·77764	38	3·78089	83	3·78412
49	3·77444	94	3·77772	39	3·78097	84	3·78419
50	3·77452	95	3·77779	40	3·78104	85	3·78426
51	3·77459	96	3·77786	41	3·78111	86	3·78433
52	3·77466	97	3·77793	42	3·78118	87	3·78440
53	3·77474	98	3·77801	43	3·78125	88	3·78447
54	3·77481	99	3·77808	44	3·78132	89	3·78455
55	3·77488	6000	3·77815	45	3·78140	90	3·78462
56	3·77495	6001	3·77822	46	3·78147	91	3·78469
57	3·77503	02	3·77830	47	3·78154	92	3·78467
58	3·77510	03	3·77837	48	3·78161	93	3·78483
59	3·77517	04	3·77844	49	3·78168	94	3·78490
60	3·77525	05	3·77851	50	3·78176	95	3·78497
61	3·77532	06	3·77859	51	3·78183	96	3·78505
62	3·77539	07	3·77866	52	3·78190	97	3·78512
63	3·77546	08	3·77873	53	3·78197	98	3·78519
64	3·77554	09	3·77880	54	3·78204	99	3·78526
65	3·77561	10	3·77887	55	3·78211	6100	3·78533
66	3·77568	11	3·77895	56	3·78219	6101	3·78540
67	3·77576	12	3·77902	57	3·78226	02	3·78547
68	3·77583	13	3·77909	58	3·78233	03	3·78554
69	3·77590	14	3·77916	59	3·78240	04	3·78561
70	3·77597	15	3·77924	60	3·78247	05	3·78569
71	3·77605	16	3·77931	61	3·78254	06	3·78576
72	3·77612	17	3·77938	62	3·78262	07	3·78583
73	3·77619	18	3·77945	63	3·78269	08	3·78590
74	3·77627	19	3·77952	64	3·78276	09	3·78597
75	3·77634	20	3·77960	65	3·78283	10	3·78604
76	3·77641	21	3·77967	66	3·78290	11	3·78611
77	3·77648	22	3·77974	67	3·78297	12	3·78618
78	3·77656	23	3·77981	68	3·78305	13	3·78625
79	3·77663	24	3·77989	69	3·78312	14	3·78633
80	3·77670	25	3·77996	70	3·78319	15	3·78640
81	3·77677	26	3·78003	71	3·78326	16	3·78647
82	3·77685	27	3·78010	72	3·78333	17	3·78654
83	3·77692	28	3·78017	73	3·78340	18	3·78661
84	3·77699	29	3·78025	74	3·78347	19	3·78668
85	3·77706	30	3·78032	75	3·78355	20	3·78675

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
6121	3.78682	6166	3.79000	6211	3.79316	6256	3.79630
22	3.78689	67	3.79007	12	3.79323	57	3.79637
23	3.78696	68	3.79014	13	3.79330	58	3.79644
24	3.78704	69	3.79021	14	3.79337	59	3.79651
25	3.78711	70	3.79029	15	3.79344	60	3.79657
26	3.78718	71	3.79036	16	3.79351	61	3.79664
27	3.78725	72	3.79043	17	3.79358	62	3.79671
28	3.78732	73	3.79050	18	3.79365	63	3.79678
29	3.78739	74	3.79057	19	3.79372	64	3.79685
30	3.78746	75	3.79064	20	3.79379	65	3.79692
31	3.78753	76	3.79071	21	3.79386	66	3.79699
32	3.78760	77	3.79078	22	3.79393	67	3.79706
33	3.78767	78	3.79085	23	3.79400	68	3.79713
34	3.78774	79	3.79092	24	3.79407	69	3.79720
35	3.78781	80	3.79099	25	3.79414	70	3.79727
36	3.78789	81	3.79106	26	3.79421	71	3.79734
37	3.78796	82	3.79113	27	3.79428	72	3.79741
38	3.78803	83	3.79120	28	3.79435	73	3.79748
39	3.78810	84	3.79127	29	3.79442	74	3.79754
40	3.78817	85	3.79134	30	3.79449	75	3.79761
41	3.78824	86	3.79141	31	3.79456	76	3.79768
42	3.78831	87	3.79148	32	3.79463	77	3.79775
43	3.78838	88	3.79155	33	3.79470	78	3.79782
44	3.78845	89	3.79162	34	3.79477	79	3.79789
45	3.78852	90	3.79169	35	3.79484	80	3.79796
46	3.78859	91	3.79176	36	3.79491	81	3.79803
47	3.78866	92	3.79183	37	3.79498	82	3.79810
48	3.78873	93	3.79190	38	3.79505	83	3.79817
49	3.78880	94	3.79197	39	3.79512	84	3.79824
50	3.78888	95	3.79204	40	3.79518	85	3.79831
51	3.78895	96	3.79211	41	3.79525	86	3.79837
52	3.78902	97	3.79218	42	3.79532	87	3.79844
53	3.78909	98	3.79225	43	3.79539	88	3.79851
54	3.78916	99	3.79232	44	3.79546	89	3.79858
55	3.78923	6200	3.79239	45	3.79553	90	3.79865
56	3.78930	6201	3.79246	46	3.79560	91	3.79872
57	3.78937	02	3.79253	47	3.79567	92	3.79879
58	3.78944	03	3.79260	48	3.79574	93	3.79886
59	3.78951	04	3.79267	49	3.79581	94	3.79893
60	3.78958	05	3.79274	50	3.79588	95	3.79900
61	3.78965	06	3.79281	51	3.79595	96	3.79906
62	3.78972	07	3.79288	52	3.79602	97	3.79913
63	3.78979	08	3.79295	53	3.79609	98	3.79920
64	3.78986	09	3.79302	54	3.79616	99	3.79927
65	3.78993	10	3.79309	55	3.79623	6300	3.79934

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
6301	3.79941	6346	3.80250	6391	3.80557	6436	3.80862
02	3.79948	47	3.80257	92	3.80564	37	3.80868
03	3.79955	48	3.80264	93	3.80570	38	3.80875
04	3.79962	49	3.80271	94	3.80577	39	3.80882
05	3.79968	50	3.80277	95	3.80584	40	3.80889
06	3.79975	51	3.80284	96	3.80591	41	3.80895
07	3.79982	52	3.80291	97	3.80598	42	3.80902
08	3.79989	53	3.80298	98	3.80604	43	3.80909
09	3.79996	54	3.80305	99	3.80611	44	3.80916
10	3.80003	55	3.80312	6400	3.80618	45	3.80922
11	3.80010	56	3.80318	6401	3.80625	46	3.80929
12	3.80017	57	3.80325	02	3.80632	47	3.80936
13	3.80024	58	3.80332	03	3.80638	48	3.80943
14	3.80030	59	3.80339	04	3.80645	49	3.80949
15	3.80037	60	3.80346	05	3.80652	50	3.80956
16	3.80044	61	3.80353	06	3.80659	51	3.80963
17	3.80051	62	3.80359	07	3.80665	52	3.80969
18	3.80058	63	3.80366	08	3.80672	53	3.80976
19	3.80065	64	3.80373	09	3.80679	54	3.80983
20	3.80072	65	3.80380	10	3.80686	55	3.80990
21	3.80079	66	3.80387	11	3.80693	56	3.80996
22	3.80085	67	3.80393	12	3.80699	57	3.81003
23	3.80092	68	3.80400	13	3.80706	58	3.81010
24	3.80099	69	3.80407	14	3.80713	59	3.81017
25	3.80106	70	3.80414	15	3.80720	60	3.81023
26	3.80117	71	3.80421	16	3.80726	61	3.81030
27	3.80120	72	3.80428	17	3.80733	62	3.81037
28	3.80127	73	3.80434	18	3.80740	63	3.81043
29	3.80134	74	3.80441	19	3.80747	64	3.81050
30	3.80140	75	3.80448	20	3.80754	65	3.81057
31	3.80145	76	3.80455	21	3.80760	66	3.81064
32	3.80154	77	3.80462	22	3.80767	67	3.81070
33	3.80161	78	3.80468	23	3.80774	68	3.81077
34	3.80168	79	3.80475	24	3.80781	69	3.81084
35	3.80175	80	3.80482	25	3.80787	70	3.81090
36	3.80182	81	3.80489	26	3.80794	71	3.81097
37	3.80188	82	3.80496	27	3.80801	72	3.81104
38	3.80195	83	3.80502	28	3.80808	73	3.81111
39	3.80202	84	3.80509	29	3.80814	74	3.81118
40	3.80209	85	3.80516	30	3.80821	75	3.81124
41	3.80216	86	3.80523	31	3.80828	76	3.81131
42	3.80223	87	3.80530	32	3.80835	77	3.81137
43	3.80229	88	3.80536	33	3.80841	78	3.81144
44	3.80236	89	3.80543	34	3.80848	79	3.81151
45	3.80243	90	3.80550	35	3.80855	80	3.81158

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
6481	3.81164	6526	3.81465	6571	3.81763	6616	3.82060
82	3.81171	27	3.81471	72	3.81770	17	3.82066
83	3.81178	28	3.81478	73	3.81776	18	3.82073
84	3.81184	29	3.81485	74	3.81783	19	3.82079
85	3.81191	30	3.81491	75	3.81790	20	3.82086
86	3.81198	31	3.81498	76	3.81796	21	3.82092
87	3.81204	32	3.81505	77	3.81803	22	3.82099
88	3.81211	33	3.81511	78	3.81809	23	3.82105
89	3.81218	34	3.81518	79	3.81816	24	3.82112
90	3.81224	35	3.81525	80	3.81823	25	3.82119
91	3.81231	36	3.81531	81	3.81829	26	3.82125
92	3.81238	37	3.81538	82	3.81836	27	3.82132
93	3.81245	38	3.81544	83	3.81842	28	3.82138
94	3.81251	39	3.81551	84	3.81849	29	3.82145
95	3.81258	40	3.81558	85	3.81856	30	3.82151
96	3.81265	41	3.81564	86	3.81862	31	3.82158
97	3.81271	42	3.81571	87	3.81869	32	3.82164
98	3.81278	43	3.81578	88	3.81875	33	3.82171
99	3.81285	44	3.81584	89	3.81882	34	3.82178
6500	3.81291	45	3.81591	90	3.81889	35	3.82184
6501	3.81298	46	3.81598	91	3.81895	36	3.82191
02	3.81305	47	3.81604	92	3.81902	37	3.82197
03	3.81311	48	3.81611	93	3.81908	38	3.82204
04	3.81318	49	3.81618	94	3.81915	39	3.82210
05	3.81325	50	3.81624	95	3.81921	40	3.82217
06	3.81331	51	3.81631	96	3.81928	41	3.82223
07	3.81338	52	3.81637	97	3.81935	42	3.82230
08	3.81345	53	3.81644	98	3.81941	43	3.82236
09	3.81351	54	3.81651	99	3.81948	44	3.82243
10	3.81358	55	3.81657	6600	3.81954	45	3.82250
11	3.81365	56	3.81664	6601	3.81961	46	3.82256
12	3.81371	57	3.81671	02	3.81968	47	3.82263
13	3.81378	58	3.81677	03	3.81974	48	3.82269
14	3.81385	59	3.81684	04	3.81981	49	3.82276
15	3.81391	60	3.81690	05	3.81987	50	3.82282
16	3.81398	61	3.81697	06	3.81994	51	3.82289
17	3.81405	62	3.81704	07	3.82000	52	3.82295
18	3.81411	63	3.81710	08	3.82007	53	3.82302
19	3.81418	64	3.81717	09	3.82014	54	3.82308
20	3.81425	65	3.81723	10	3.82020	55	3.82315
21	3.81431	66	3.81730	11	3.82027	56	3.82321
22	3.81438	67	3.81737	12	3.82033	57	3.82328
23	3.81445	68	3.81743	13	3.82040	58	3.82334
24	3.81451	69	3.81750	14	3.82046	59	3.82341
25	3.81458	70	3.81757	15	3.82053	60	3.82347

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
6661	3.82354	6706	3.82646	6751	3.82937	6796	3.83225
62	3.82360	07	3.82653	52	3.82943	97	3.83232
63	3.82367	08	3.82659	53	3.82950	98	3.83238
64	3.82374	09	3.82666	54	3.82956	99	3.83245
65	3.82380	10	3.82672	55	3.82963	6800	3.83251
66	3.82387	11	3.82679	56	3.82969	6801	3.83257
67	3.82393	12	3.82685	57	3.82975	02	3.83264
68	3.82400	13	3.82692	58	3.82982	03	3.83270
69	3.82406	14	3.82698	59	3.82988	04	3.83276
70	3.82413	15	3.82705	60	3.82995	05	3.83283
71	3.82419	16	3.82711	61	3.83001	06	3.83289
72	3.82426	17	3.82718	62	3.83008	07	3.83296
73	3.82432	18	3.82724	63	3.83014	08	3.83302
74	3.82439	19	3.82730	64	3.83020	09	3.83308
75	3.82445	20	3.82737	65	3.83027	10	3.83315
76	3.82452	21	3.82743	66	3.83033	11	3.83321
77	3.82458	22	3.82750	67	3.83040	12	3.83327
78	3.82465	23	3.82756	68	3.83046	13	3.83334
79	3.82471	24	3.82763	69	3.83052	14	3.83340
80	3.82478	25	3.82769	70	3.83059	15	3.83347
81	3.82484	26	3.82776	71	3.83065	16	3.83353
82	3.82491	27	3.82782	72	3.83072	17	3.83359
83	3.82497	28	3.82789	73	3.83078	18	3.83366
84	3.82504	29	3.82795	74	3.83085	19	3.83372
85	3.82510	30	3.82802	75	3.83091	20	3.83378
86	3.82517	31	3.82808	76	3.83097	21	3.83385
87	3.82523	32	3.82814	77	3.83104	22	3.83391
88	3.82530	33	3.82821	78	3.83110	23	3.83398
89	3.82536	34	3.82827	79	3.83117	24	3.83404
90	3.82543	35	3.82834	80	3.83123	25	3.83410
91	3.82549	36	3.82840	81	3.83129	26	3.83417
92	3.82556	37	3.82847	82	3.83136	27	3.83423
93	3.82562	38	3.82853	83	3.83142	28	3.83429
94	3.82569	39	3.82860	84	3.83149	29	3.83436
95	3.82575	40	3.82866	85	3.83155	30	3.83442
96	3.82582	41	3.82872	86	3.83161	31	3.83448
97	3.82588	42	3.82879	87	3.83168	32	3.83455
98	3.82595	43	3.82885	88	3.83174	33	3.83461
99	3.82601	44	3.82892	89	3.83181	34	3.83468
6700	3.82607	45	3.82898	90	3.83187	35	3.83474
6701	3.82614	46	3.82905	91	3.83193	36	3.83480
02	3.82620	47	3.82911	92	3.83200	37	3.83487
03	3.82627	48	3.82918	93	3.83206	38	3.83493
04	3.82633	49	3.82924	94	3.83213	39	3.83499
05	3.82640	50	3.82930	95	3.83219	40	3.83506

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
6841	3.83512	6886	3.83797	6931	3.84080	6976	3.84361
42	3.83518	87	3.83803	32	3.84086	77	3.84367
43	3.83525	88	3.83809	33	3.84092	78	3.84373
44	3.83531	89	3.83816	34	3.84098	79	3.84379
45	3.83537	90	3.83822	35	3.84105	80	3.84386
46	3.83544	91	3.83828	36	3.84111	81	3.84392
47	3.83550	92	3.83835	37	3.84117	82	3.84398
48	3.83556	93	3.83841	38	3.84123	83	3.84404
49	3.83563	94	3.83847	39	3.84130	84	3.84410
50	3.83569	95	3.83853	40	3.84136	85	3.84417
51	3.83575	96	3.83860	41	3.84142	86	3.84423
52	3.83582	97	3.83866	42	3.84148	87	3.84429
53	3.83588	98	3.83872	43	3.84155	88	3.84435
54	3.83594	99	3.83879	44	3.84161	89	3.84442
55	3.83601	6900	3.83885	45	3.84167	90	3.84448
56	3.83607	6901	3.83891	46	3.84173	91	3.84454
57	3.83613	02	3.83898	47	3.84180	92	3.84460
58	3.83620	03	3.83904	48	3.84186	93	3.84466
59	3.83626	04	3.83910	49	3.84192	94	3.84473
60	3.83632	05	3.83916	50	3.84198	95	3.84479
61	3.83639	06	3.83923	51	3.84205	96	3.84485
62	3.83645	07	3.83929	52	3.84211	97	3.84491
63	3.83651	08	3.83935	53	3.84217	98	3.84497
64	3.83658	09	3.83942	54	3.84223	99	3.84504
65	3.83664	10	3.83948	55	3.84230	7000	3.84510
66	3.83670	11	3.83954	56	3.84236	7001	3.84516
67	3.83677	12	3.83960	57	3.84242	02	3.84522
68	3.83683	13	3.83967	58	3.84248	03	3.84528
69	3.83689	14	3.83973	59	3.84255	04	3.84535
70	3.83696	15	3.83979	60	3.84261	05	3.84541
71	3.83702	16	3.83986	61	3.84267	06	3.84547
72	3.83708	17	3.83992	62	3.84273	07	3.84553
73	3.83715	18	3.83998	63	3.84280	08	3.84559
74	3.83721	19	3.84004	64	3.84286	09	3.84566
75	3.83727	20	3.84011	65	3.84292	10	3.84572
76	3.83734	21	3.84017	66	3.84298	11	3.84578
77	3.83740	22	3.84023	67	3.84305	12	3.84584
78	3.83746	23	3.84029	68	3.84311	13	3.84590
79	3.83753	24	3.84036	69	3.84317	14	3.84597
80	3.83759	25	3.84042	70	3.84323	15	3.84603
81	3.83765	26	3.84048	71	3.84330	16	3.84609
82	3.83771	27	3.84055	72	3.84336	17	3.84615
83	3.83778	28	3.84061	73	3.84342	18	3.84621
84	3.83784	29	3.84067	74	3.84348	19	3.84628
85	3.83790	30	3.84073	75	3.84354	20	3.84634

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
7021	3.84640	7066	3.84917	7111	3.85193	7156	3.85467
22	3.84646	67	3.84924	12	3.85199	57	3.85473
23	3.84652	68	3.84930	13	3.85205	58	3.85479
24	3.84658	69	3.84936	14	3.85211	59	3.85485
25	3.84665	70	3.84942	15	3.85217	60	3.85491
26	3.84671	71	3.84948	16	3.85224	61	3.85497
27	3.84677	72	3.84954	17	3.85230	62	3.85503
28	3.84683	73	3.84960	18	3.85236	63	3.85509
29	3.84689	74	3.84967	19	3.85242	64	3.85516
30	3.84696	75	3.84973	20	3.85248	65	3.85522
31	3.84702	76	3.84979	21	3.85254	66	3.85528
32	3.84708	77	3.84985	22	3.85260	67	3.85534
33	3.84714	78	3.84991	23	3.85266	68	3.85540
34	3.84720	79	3.84997	24	3.85272	69	3.85546
35	3.84726	80	3.85003	25	3.85278	70	3.85552
36	3.84733	81	3.85009	26	3.85285	71	3.85558
37	3.84739	82	3.85016	27	3.85291	72	3.85564
38	3.84745	83	3.85022	28	3.85297	73	3.85570
39	3.84751	84	3.85028	29	3.85303	74	3.85576
40	3.84757	85	3.85034	30	3.85309	75	3.85582
41	3.84763	86	3.85040	31	3.85315	76	3.85588
42	3.84770	87	3.85046	32	3.85321	77	3.85594
43	3.84776	88	3.85052	33	3.85327	78	3.85600
44	3.84782	89	3.85058	34	3.85333	79	3.85606
45	3.84788	90	3.85065	35	3.85339	80	3.85612
46	3.84794	91	3.85071	36	3.85345	81	3.85618
47	3.84800	92	3.85077	37	3.85352	82	3.85625
48	3.84807	93	3.85083	38	3.85358	83	3.85631
49	3.84813	94	3.85089	39	3.85364	84	3.85637
50	3.84819	95	3.85095	40	3.85370	85	3.85643
51	3.84825	96	3.85101	41	3.85376	86	3.85649
52	3.84831	97	3.85107	42	3.85382	87	3.85655
53	3.84837	98	3.85114	43	3.85388	88	3.85661
54	3.84844	99	3.85120	44	3.85394	89	3.85667
55	3.84850	7100	3.85126	45	3.85400	90	3.85673
56	3.84856	7101	3.85132	46	3.85406	91	3.85679
57	3.84862	02	3.85138	47	3.85412	92	3.85685
58	3.84868	03	3.85144	48	3.85418	93	3.85691
59	3.84874	04	3.85150	49	3.85425	94	3.85697
60	3.84880	05	3.85156	50	3.85431	95	3.85703
61	3.84887	06	3.85163	51	3.85437	96	3.85709
62	3.84893	07	3.85169	52	3.85443	97	3.85715
63	3.84899	08	3.85175	53	3.85449	98	3.85721
64	3.84905	09	3.85181	54	3.85455	99	3.85727
65	3.84911	10	3.85187	55	3.85461	7200	3.85733

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
7201	3.85739	7246	3.86010	7291	3.86279	7336	3.86546
02	3.85745	47	3.86016	92	3.86285	37	3.86552
03	3.85751	48	3.86022	93	3.86291	38	3.86558
04	3.85757	49	3.86028	94	3.86297	39	3.86564
05	3.85763	50	3.86034	95	3.86303	40	3.86570
06	3.85769	51	3.86040	96	3.86308	41	3.86576
07	3.85775	52	3.86046	97	3.86314	42	3.86581
08	3.85781	53	3.86052	98	3.86320	43	3.86587
09	3.85788	54	3.86058	99	3.86326	44	3.86593
10	3.85794	55	3.86064	7300	3.86332	45	3.86599
11	3.85800	56	3.86070	7301	3.86338	46	3.86605
12	3.85806	57	3.86076	02	3.86344	47	3.86611
13	3.85812	58	3.86082	03	3.86350	48	3.86617
14	3.85818	59	3.86088	04	3.86356	49	3.86623
15	3.85824	60	3.86094	05	3.86362	50	3.86629
16	3.85830	61	3.86100	06	3.86368	51	3.86635
17	3.85836	62	3.86106	07	3.86374	52	3.86641
18	3.85842	63	3.86112	08	3.86380	53	3.86646
19	3.85848	64	3.86118	09	3.86386	54	3.86652
20	3.85854	65	3.86124	10	3.86392	55	3.86658
21	3.85860	66	3.86130	11	3.86398	56	3.86664
22	3.85866	67	3.86136	12	3.86404	57	3.86670
23	3.85872	68	3.86141	13	3.86410	58	3.86676
24	3.85878	69	3.86147	14	3.86416	59	3.86682
25	3.85884	70	3.86153	15	3.86421	60	3.86688
26	3.85890	71	3.86159	16	3.86427	61	3.86694
27	3.85896	72	3.86165	17	3.86433	62	3.86700
28	3.85902	73	3.86171	18	3.86439	63	3.86705
29	3.85908	74	3.86177	19	3.86445	64	3.86711
30	3.85914	75	3.86183	20	3.86451	65	3.86717
31	3.85920	76	3.86189	21	3.86457	66	3.86723
32	3.85926	77	3.86195	22	3.86463	67	3.86729
33	3.85932	78	3.86201	23	3.86469	68	3.86735
34	3.85938	79	3.86207	24	3.86475	69	3.86741
35	3.85944	80	3.86213	25	3.86481	70	3.86747
36	3.85950	81	3.86219	26	3.86487	71	3.86753
37	3.85956	82	3.86225	27	3.86493	72	3.86759
38	3.85962	83	3.86231	28	3.86499	73	3.86764
39	3.85968	84	3.86237	29	3.86504	74	3.86770
40	3.85974	85	3.86243	30	3.86510	75	3.86776
41	3.85980	86	3.86249	31	3.86516	76	3.86782
42	3.85986	87	3.86255	32	3.86522	77	3.86788
43	3.85992	88	3.86261	33	3.86528	78	3.86794
44	3.85998	89	3.86267	34	3.86534	79	3.86800
45	3.86004	90	3.86273	35	3.86540	80	3.86806

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7381	3.86812	7426	3.87075	7471	3.87338	7516	3.87599
82	3.86817	27	3.87081	72	3.87344	17	3.87604
83	3.86823	28	3.87087	73	3.87350	18	3.87610
84	3.86829	29	3.87093	74	3.87355	19	3.87616
85	3.86835	30	3.87099	75	3.87361	20	3.87622
86	3.86841	31	3.87105	76	3.87367	21	3.87628
87	3.86847	32	3.87111	77	3.87373	22	3.87633
88	3.86853	33	3.87116	78	3.87379	23	3.87639
89	3.86859	34	3.87122	79	3.87384	24	3.87645
90	3.86864	35	3.87128	80	3.87390	25	3.87651
91	3.86870	36	3.87134	81	3.87396	26	3.87656
92	3.86876	37	3.87140	82	3.87402	27	3.87662
93	3.86882	38	3.87146	83	3.87408	28	3.87668
94	3.86888	39	3.87151	84	3.87413	29	3.87674
95	3.86894	40	3.87157	85	3.87419	30	3.87680
96	3.86900	41	3.87163	86	3.87425	31	3.87685
97	3.86906	42	3.87169	87	3.87431	32	3.87691
98	3.86911	43	3.87175	88	3.87437	33	3.87697
99	3.86917	44	3.87181	89	3.87442	34	3.87703
7400	3.86923	45	3.87186	90	3.87448	35	3.87708
7401	3.86929	46	3.87192	91	3.87454	36	3.87714
02	3.86935	47	3.87198	92	3.87460	37	3.87720
03	3.86941	48	3.87204	93	3.87466	38	3.87726
04	3.86947	49	3.87210	94	3.87471	39	3.87731
05	3.86953	50	3.87216	95	3.87477	40	3.87737
06	3.86958	51	3.87221	96	3.87483	41	3.87743
07	3.86964	52	3.87227	97	3.87489	42	3.87749
08	3.86970	53	3.87233	98	3.87495	43	3.87754
09	3.86976	54	3.87239	99	3.87500	44	3.87760
10	3.86982	55	3.87245	7500	3.87506	45	3.87766
11	3.86988	56	3.87251	7501	3.87512	46	3.87772
12	3.86994	57	3.87256	02	3.87518	47	3.87777
13	3.86999	58	3.87262	03	3.87523	48	3.87783
14	3.87005	59	3.87268	04	3.87529	49	3.87789
15	3.87011	60	3.87274	05	3.87535	50	3.87795
16	3.87017	61	3.87280	06	3.87541	51	3.87800
17	3.87023	62	3.87286	07	3.87547	52	3.87806
18	3.87029	63	3.87291	08	3.87552	53	3.87812
19	3.87035	64	3.87297	09	3.87558	54	3.87818
20	3.87040	65	3.87303	10	3.87564	55	3.87823
21	3.87046	66	3.87309	11	3.87570	56	3.87829
22	3.87052	67	3.87315	12	3.87576	57	3.87835
23	3.87058	68	3.87320	13	3.87581	58	3.87841
24	3.87064	69	3.87326	14	3.87587	59	3.87846
25	3.87070	70	3.87332	15	3.87593	60	3.87852

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
7561	3.87858	7606	3.88116	7651	3.88372	7696	3.88627
62	3.87864	07	3.88121	52	3.88378	97	3.88632
63	3.87869	08	3.88127	53	3.88383	98	3.88638
64	3.87875	09	3.88133	54	3.88389	99	3.88643
65	3.87881	10	3.88138	55	3.88395	7700	3.88649
66	3.87887	11	3.88144	56	3.88400	7701	3.88655
67	3.87892	12	3.88150	57	3.88406	02	3.88660
68	3.87898	13	3.88156	58	3.88412	03	3.88666
69	3.87904	14	3.88161	59	3.88417	04	3.88672
70	3.87910	15	3.88167	60	3.88423	05	3.88677
71	3.87915	16	3.88173	61	3.88429	06	3.88683
72	3.87921	17	3.88178	62	3.88434	07	3.88689
73	3.87927	18	3.88184	63	3.88440	08	3.88694
74	3.87933	19	3.88190	64	3.88446	09	3.88700
75	3.87938	20	3.88196	65	3.88451	10	3.88705
76	3.87944	21	3.88201	66	3.88457	11	3.88711
77	3.87950	22	3.88207	67	3.88463	12	3.88717
78	3.87955	23	3.88213	68	3.88468	13	3.88722
79	3.87961	24	3.88218	69	3.88474	14	3.88728
80	3.87967	25	3.88224	70	3.88480	15	3.88734
81	3.87973	26	3.88230	71	3.88485	16	3.88739
82	3.87978	27	3.88235	72	3.88491	17	3.88745
83	3.87984	28	3.88241	73	3.88497	18	3.88750
84	3.87990	29	3.88247	74	3.88502	19	3.88756
85	3.87996	30	3.88252	75	3.88508	20	3.88762
86	3.88001	31	3.88258	76	3.88514	21	3.88767
87	3.88007	32	3.88264	77	3.88519	22	3.88773
88	3.88013	33	3.88270	78	3.88525	23	3.88779
89	3.88018	34	3.88275	79	3.88530	24	3.88784
90	3.88024	35	3.88281	80	3.88536	25	3.88790
91	3.88030	36	3.88287	81	3.88542	26	3.88795
92	3.88036	37	3.88292	82	3.88547	27	3.88801
93	3.88041	38	3.88298	83	3.88553	28	3.88807
94	3.88047	39	3.88304	84	3.88559	29	3.88812
95	3.88053	40	3.88309	85	3.88564	30	3.88818
96	3.88059	41	3.88315	86	3.88570	31	3.88824
97	3.88064	42	3.88321	87	3.88576	32	3.88829
98	3.88070	43	3.88326	88	3.88581	33	3.88835
99	3.88076	44	3.88332	89	3.88587	34	3.88840
7600	3.88081	45	3.88338	90	3.88593	35	3.88846
7601	3.88087	46	3.88343	91	3.88598	36	3.88852
02	3.88093	47	3.88349	92	3.88604	37	3.88857
03	3.88099	48	3.88355	93	3.88610	38	3.88863
04	3.88104	49	3.88360	94	3.88615	39	3.88868
05	3.88110	50	3.88366	95	3.88621	40	3.88874

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
7741	3.88880	7786	3.89131	7831	3.89382	7876	3.89631
42	3.88885	87	3.89137	32	3.89387	77	3.89636
43	3.88891	88	3.89143	33	3.89393	78	3.89642
44	3.88897	89	3.89148	34	3.89398	79	3.89647
45	3.88902	90	3.89154	35	3.89404	80	3.89653
46	3.88908	91	3.89159	36	3.89409	81	3.89658
47	3.88913	92	3.89165	37	3.89415	82	3.89664
48	3.88919	93	3.89170	38	3.89421	83	3.89669
49	3.88925	94	3.89176	39	3.89426	84	3.89675
50	3.88930	95	3.89182	40	3.89432	85	3.89680
51	3.88936	96	3.89187	41	3.89437	86	3.89686
52	3.88941	97	3.89193	42	3.89443	87	3.89691
53	3.88947	98	3.89198	43	3.89448	88	3.89697
54	3.88953	99	3.89204	44	3.89454	89	3.89702
55	3.88958	7800	3.89209	45	3.89459	90	3.89708
56	3.88964	7801	3.89215	46	3.89465	91	3.89713
57	3.88969	02	3.89221	47	3.89470	92	3.89719
58	3.88975	03	3.89226	48	3.89476	93	3.89724
59	3.88981	04	3.89232	49	3.89481	94	3.89730
60	3.88986	05	3.89237	50	3.89487	95	3.89735
61	3.88992	06	3.89243	51	3.89493	96	3.89741
62	3.88997	07	3.89248	52	3.89498	97	3.89746
63	3.89003	08	3.89254	53	3.89504	98	3.89752
64	3.89009	09	3.89260	54	3.89509	99	3.89757
65	3.89014	10	3.89265	55	3.89515	7900	3.89763
66	3.89020	11	3.89271	56	3.89520	7901	3.89768
67	3.89025	12	3.89276	57	3.89526	02	3.89774
68	3.89031	13	3.89282	58	3.89531	03	3.89779
69	3.89037	14	3.89287	59	3.89537	04	3.89785
70	3.89042	15	3.89293	60	3.89542	05	3.89790
71	3.89048	16	3.89298	61	3.89548	06	3.89796
72	3.89053	17	3.89304	62	3.89553	07	3.89801
73	3.89059	18	3.89310	63	3.89559	08	3.89807
74	3.89064	19	3.89315	64	3.89564	09	3.89812
75	3.89070	20	3.89321	65	3.89570	10	3.89818
76	3.89076	21	3.89326	66	3.89575	11	3.89823
77	3.89081	22	3.89332	67	3.89581	12	3.89829
78	3.89087	23	3.89337	68	3.89586	13	3.89834
79	3.89092	24	3.89343	69	3.89592	14	3.89840
80	3.89098	25	3.89348	70	3.89597	15	3.89845
81	3.89104	26	3.89354	71	3.89603	16	3.89851
82	3.89109	27	3.89360	72	3.89609	17	3.89856
83	3.89115	28	3.89365	73	3.89614	18	3.89862
84	3.89120	29	3.89371	74	3.89620	19	3.89867
85	3.89126	30	3.89376	75	3.89625	20	3.89873

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
7921	3.89878	7966	3.90124	8011	3.90369	8056	3.90612
22	3.89883	67	3.90129	12	3.90374	57	3.90617
23	3.89889	68	3.90135	13	3.90380	58	3.90623
24	3.89894	69	3.90140	14	3.90385	59	3.90628
25	3.89900	70	3.90146	15	3.90390	60	3.90634
26	3.89905	71	3.90151	16	3.90396	61	3.90639
27	3.89911	72	3.90157	17	3.90401	62	3.90644
28	3.89916	73	3.90162	18	3.90407	63	3.90650
29	3.89922	74	3.90168	19	3.90412	64	3.90655
30	3.89927	75	3.90173	20	3.90417	65	3.90660
31	3.89933	76	3.90179	21	3.90423	66	3.90666
32	3.89938	77	3.90184	22	3.90428	67	3.90671
33	3.89944	78	3.90189	23	3.90434	68	3.90677
34	3.89949	79	3.90195	24	3.90439	69	3.90682
35	3.89955	80	3.90200	25	3.90445	70	3.90687
36	3.89960	81	3.90206	26	3.90450	71	3.90693
37	3.89966	82	3.90211	27	3.90455	72	3.90698
38	3.89971	83	3.90217	28	3.90461	73	3.90704
39	3.89977	84	3.90222	29	3.90466	74	3.90709
40	3.89982	85	3.90227	30	3.90472	75	3.90714
41	3.89988	86	3.90233	31	3.90477	76	3.90720
42	3.89993	87	3.90238	32	3.90482	77	3.90725
43	3.89998	88	3.90244	33	3.90488	78	3.90730
44	3.90004	89	3.90249	34	3.90493	79	3.90736
45	3.90009	90	3.90255	35	3.90499	80	3.90741
46	3.90015	91	3.90260	36	3.90504	81	3.90747
47	3.90020	92	3.90266	37	3.90509	82	3.90752
48	3.90026	93	3.90271	38	3.90515	83	3.90757
49	3.90031	94	3.90276	39	3.90520	84	3.90763
50	3.90037	95	3.90282	40	3.90526	85	3.90768
51	3.90042	96	3.90287	41	3.90531	86	3.90773
52	3.90048	97	3.90293	42	3.90536	87	3.90779
53	3.90053	98	3.90298	43	3.90542	88	3.90784
54	3.90059	99	3.90304	44	3.90547	89	3.90789
55	3.90064	8000	3.90309	45	3.90553	90	3.90795
56	3.90066	8001	3.90314	46	3.90558	91	3.90800
57	3.90075	02	3.90320	47	3.90563	92	3.90806
58	3.90080	03	3.90325	48	3.90569	93	3.90811
59	3.90086	04	3.90331	49	3.90574	94	3.90816
60	3.90091	05	3.90336	50	3.90580	95	3.90822
61	3.90097	06	3.90342	51	3.90585	96	3.90827
62	3.90102	07	3.90347	52	3.90590	97	3.90832
63	3.90108	08	3.90352	53	3.90596	98	3.90838
64	3.90113	09	3.90358	54	3.90601	99	3.90843
65	3.90119	10	3.90363	55	3.90607	8100	3.90849

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
8101	3.90854	8146	3.91094	8191	3.91334	8236	3.91572
02	3.90859	47	3.91100	92	3.91339	37	3.91577
03	3.90865	48	3.91105	93	3.91344	38	3.91582
04	3.90870	49	3.91110	94	3.91350	39	3.91587
05	3.90875	50	3.91116	95	3.91355	40	3.91593
06	3.90881	51	3.91121	96	3.91360	41	3.91598
07	3.90886	52	3.91126	97	3.91365	42	3.91603
08	3.90891	53	3.91132	98	3.91371	43	3.91609
09	3.90897	54	3.91137	99	3.91376	44	3.91614
10	3.90902	55	3.91142	8200	3.91381	45	3.91619
11	3.90907	56	3.91148	8201	3.91387	46	3.91624
12	3.90913	57	3.91153	02	3.91392	47	3.91630
13	3.90918	58	3.91158	03	3.91397	48	3.91635
14	3.90924	59	3.91164	04	3.91403	49	3.91640
15	3.90929	60	3.91169	05	3.91408	50	3.91645
16	3.90934	61	3.91174	06	3.91413	51	3.91651
17	3.90940	62	3.91180	07	3.91418	52	3.91656
18	3.90945	63	3.91185	08	3.91424	53	3.91661
19	3.90950	64	3.91190	09	3.91429	54	3.91666
20	3.90956	65	3.91196	10	3.91434	55	3.91672
21	3.90961	66	3.91201	11	3.91440	56	3.91677
22	3.90966	67	3.91206	12	3.91445	57	3.91682
23	3.90972	68	3.91212	13	3.91450	58	3.91687
24	3.90977	69	3.91217	14	3.91455	59	3.91693
25	3.90982	70	3.91222	15	3.91461	60	3.91698
26	3.90988	71	3.91228	16	3.91466	61	3.91703
27	3.90993	72	3.91232	17	3.91471	62	3.91709
28	3.90998	73	3.91238	18	3.91477	63	3.91714
29	3.91004	74	3.91243	19	3.91482	64	3.91719
30	3.91009	75	3.91249	20	3.91487	65	3.91724
31	3.91014	76	3.91254	21	3.91492	66	3.91730
32	3.91020	77	3.91259	22	3.91498	67	3.91735
33	3.91025	78	3.91265	23	3.91503	68	3.91740
34	3.91030	79	3.91270	24	3.91508	69	3.91745
35	3.91036	80	3.91275	25	3.91514	70	3.91751
36	3.91041	81	3.91281	26	3.91519	71	3.91756
37	3.91046	82	3.91286	27	3.91524	72	3.91761
38	3.91052	83	3.91291	28	3.91529	73	3.91766
39	3.91057	84	3.91297	29	3.91535	74	3.91772
40	3.91062	85	3.91302	30	3.91540	75	3.91777
41	3.91068	86	3.91307	31	3.91545	76	3.91782
42	3.91073	87	3.91312	32	3.91551	77	3.91787
43	3.91078	88	3.91318	33	3.91556	78	3.91793
44	3.91084	89	3.91323	34	3.91561	79	3.91798
45	3.91089	90	3.91328	35	3.91566	80	3.91803

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
8281	3.91808	8326	3.92044	8371	3.92278	8416	3.92511
82	3.91814	27	3.92049	72	3.92283	17	3.92516
83	3.91819	28	3.92054	73	3.92288	18	3.92521
84	3.91824	29	3.92059	74	3.92293	19	3.92526
85	3.91829	30	3.92065	75	3.92298	20	3.92531
86	3.91834	31	3.92070	76	3.92304	21	3.92536
87	3.91840	32	3.92075	77	3.92309	22	3.92542
88	3.91845	33	3.92080	78	3.92314	23	3.92547
89	3.91850	34	3.92085	79	3.92319	24	3.92552
90	3.91855	35	3.92091	80	3.92324	25	3.92557
91	3.91861	36	3.92096	81	3.92330	26	3.92562
92	3.91866	37	3.92101	82	3.92335	27	3.92567
93	3.91871	38	3.92106	83	3.92340	28	3.92572
94	3.91876	39	3.92111	84	3.92345	29	3.92578
95	3.91882	40	3.92117	85	3.92350	30	3.92583
96	3.91887	41	3.92122	86	3.92355	31	3.92588
97	3.91892	42	3.92127	87	3.92361	32	3.92593
98	3.91897	43	3.92132	88	3.92366	33	3.92598
99	3.91903	44	3.92137	89	3.92371	34	3.92603
8300	3.91908	45	3.92143	90	3.92376	35	3.92609
8301	3.91913	46	3.92148	91	3.92381	36	3.92614
02	3.91918	47	3.92153	92	3.92387	37	3.92619
03	3.91924	48	3.92158	93	3.92392	38	3.92624
04	3.91929	49	3.92163	94	3.92397	39	3.92629
05	3.91934	50	3.92169	95	3.92402	40	3.92634
06	3.91939	51	3.92174	96	3.92407	41	3.92639
07	3.91944	52	3.92179	97	3.92412	42	3.92645
08	3.91950	53	3.92184	98	3.92418	43	3.92650
09	3.91955	54	3.92189	99	3.92423	44	3.92655
10	3.91960	55	3.92195	8400	3.92428	45	3.92660
11	3.91965	56	3.92200	8401	3.92433	46	3.92665
12	3.91971	57	3.92205	02	3.92438	47	3.92670
13	3.91976	58	3.92210	03	3.92443	48	3.92675
14	3.91981	59	3.92215	04	3.92449	49	3.92681
15	3.91986	60	3.92221	05	3.92454	50	3.92686
16	3.91991	61	3.92226	06	3.92459	51	3.92691
17	3.91997	62	3.92231	07	3.92464	52	3.92696
18	3.92002	63	3.92236	08	3.92469	53	3.92701
19	3.92007	64	3.92241	09	3.92474	54	3.92706
20	3.92012	65	3.92247	10	3.92480	55	3.92711
21	3.92018	66	3.92252	11	3.92485	56	3.92717
22	3.92023	67	3.92257	12	3.92490	57	3.92722
23	3.92028	68	3.92262	13	3.92495	58	3.92727
24	3.92033	69	3.92267	14	3.92500	59	3.92732
25	3.92038	70	3.92273	15	3.92505	60	3.92737

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
8461	3.92742	8506	3.92973	8551	3.93201	8596	3.93430
62	3.92747	07	3.92978	52	3.93207	97	3.93435
63	3.92752	08	3.92983	53	3.93212	98	3.93440
64	3.92758	09	3.92988	54	3.93217	99	3.93445
65	3.92763	10	3.92993	55	3.93222	8600	3.93450
66	3.92768	11	3.92998	56	3.93227	8601	3.93455
67	3.92773	12	3.93003	57	3.93232	02	3.93460
68	3.92778	13	3.93008	58	3.93237	03	3.93465
69	3.92783	14	3.93013	59	3.93242	04	3.93470
70	3.92788	15	3.93018	60	3.93247	05	3.93475
71	3.92793	16	3.93024	61	3.93252	06	3.93480
72	3.92799	17	3.93029	62	3.93257	07	3.93485
73	3.92804	18	3.93034	63	3.93263	08	3.93490
74	3.92809	19	3.93039	64	3.93268	09	3.93495
75	3.92814	20	3.93044	65	3.93273	10	3.93500
76	3.92819	21	3.93049	66	3.93278	11	3.93505
77	3.92824	22	3.93054	67	3.93283	12	3.93510
78	3.92829	23	3.93059	68	3.93288	13	3.93515
79	3.92834	24	3.93064	69	3.93293	14	3.93520
80	3.92840	25	3.93069	70	3.93298	15	3.93526
81	3.92845	26	3.93075	71	3.93303	16	3.93531
82	3.92850	27	3.93080	72	3.93308	17	3.93536
83	3.92855	28	3.93085	73	3.93313	18	3.93541
84	3.92860	29	3.93090	74	3.93318	19	3.93546
85	3.92865	30	3.93095	75	3.93323	20	3.93551
86	3.92870	31	3.93100	76	3.93328	21	3.93556
87	3.92875	32	3.93105	77	3.93334	22	3.93561
88	3.92881	33	3.93110	78	3.93339	23	3.93566
89	3.92886	34	3.93115	79	3.93344	24	3.93571
90	3.92891	35	3.93120	80	3.93349	25	3.93576
91	3.92896	36	3.93125	81	3.93354	26	3.93581
92	3.92901	37	3.93131	82	3.93359	27	3.93586
93	3.92906	38	3.93136	83	3.93364	28	3.93591
94	3.92911	39	3.93141	84	3.93369	29	3.93596
95	3.92916	40	3.93146	85	3.93374	30	3.93601
96	3.92921	41	3.93151	86	3.93379	31	3.93606
97	3.92927	42	3.93156	87	3.93384	32	3.93611
98	3.92932	43	3.93161	88	3.93389	33	3.93616
99	3.92937	44	3.93166	89	3.93394	34	3.93621
8500	3.92942	45	3.93171	90	3.93399	35	3.93626
8501	3.92947	46	3.93176	91	3.93404	36	3.93631
02	3.92952	47	3.93181	92	3.93409	37	3.93636
03	3.92957	48	3.93186	93	3.93414	38	3.93641
04	3.92962	49	3.93192	94	3.93420	39	3.93646
05	3.92967	50	3.93197	95	3.93425	40	3.93651

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
8641	3.93656	8686	3.93882	8731	3.94106	8776	3.94330
42	3.93661	87	3.93887	32	3.94111	77	3.94335
43	3.93666	88	3.93892	33	3.94116	78	3.94340
44	3.93671	89	3.93897	34	3.94121	79	3.94345
45	3.93677	90	3.93902	35	3.94126	80	3.94349
46	3.93682	91	3.93907	36	3.94131	81	3.94354
47	3.93687	92	3.93912	37	3.94136	82	3.94359
48	3.93692	93	3.93917	38	3.94141	83	3.94364
49	3.93697	94	3.93922	39	3.94146	84	3.94369
50	3.93702	95	3.93927	40	3.94151	85	3.94374
51	3.93707	96	3.93932	41	3.94150	86	3.94379
52	3.93712	97	3.93937	42	3.94161	87	3.94384
53	3.93717	98	3.93942	43	3.94166	88	3.94389
54	3.93722	99	3.93947	44	3.94171	89	3.94394
55	3.93727	8700	3.93952	45	3.94176	90	3.94399
56	3.93732	8701	3.93957	46	3.94181	91	3.94404
57	3.93737	02	3.93962	47	3.94186	92	3.94409
58	3.93742	03	3.93967	48	3.94191	93	3.94414
59	3.93747	04	3.93972	49	3.94196	94	3.94419
60	3.93752	05	3.93977	50	3.94201	95	3.94424
61	3.93757	06	3.93982	51	3.94206	96	3.94429
62	3.93762	07	3.93987	52	3.94211	97	3.94433
63	3.93767	08	3.93992	53	3.94216	98	3.94438
64	3.93772	09	3.93997	54	3.94221	99	3.94443
65	3.93777	10	3.94002	55	3.94226	8800	3.94448
66	3.93782	11	3.94007	56	3.94231	8801	3.94453
67	3.93787	12	3.94012	57	3.94236	02	3.94458
68	3.93792	13	3.94017	58	3.94240	03	3.94463
69	3.93797	14	3.94022	59	3.94245	04	3.94468
70	3.93802	15	3.94027	60	3.94250	05	3.94473
71	3.93807	16	3.94032	61	3.94255	06	3.94478
72	3.93812	17	3.94037	62	3.94260	07	3.94483
73	3.93817	18	3.94042	63	3.94265	08	3.94488
74	3.93822	19	3.94047	64	3.94270	09	3.94493
75	3.93827	20	3.94052	65	3.94275	10	3.94498
76	3.93832	21	3.94057	66	3.94280	11	3.94503
77	3.93837	22	3.94062	67	3.94295	12	3.94507
78	3.93842	23	3.94067	68	3.94290	13	3.94512
79	3.93847	24	3.94072	69	3.94295	14	3.94517
80	3.93852	25	3.94077	70	3.94300	15	3.94522
81	3.93857	26	3.94082	71	3.94305	16	3.94527
82	3.93862	27	3.94087	72	3.94310	17	3.94532
83	3.93867	28	3.94091	73	3.94315	18	3.94537
84	3.93872	29	3.94096	74	3.94320	19	3.94542
85	3.93877	30	3.94101	75	3.94325	20	3.94547

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
8821	3·94552	8866	3·94773	8911	3·94993	8956	3·95211
22	3·94557	67	3·94778	12	3·94998	57	3·95216
23	3·94562	68	3·94783	13	3·95002	58	3·95221
24	3·94567	69	3·94787	14	3·95007	59	3·95226
25	3·94571	70	3·94792	15	3·95012	60	3·95231
26	3·94576	71	3·94797	16	3·95017	61	3·95236
27	3·94581	72	3·94802	17	3·95022	62	3·95240
28	3·94586	73	3·94807	18	3·95027	63	3·95245
29	3·94591	74	3·94812	19	3·95032	64	3·95250
30	3·94596	75	3·94817	20	3·95036	65	3·95255
31	3·94601	76	3·94822	21	3·95041	66	3·95260
32	3·94606	77	3·94827	22	3·95046	67	3·95265
33	3·94611	78	3·94832	23	3·95051	68	3·95270
34	3·94616	79	3·94836	24	3·95056	69	3·95274
35	3·94621	80	3·94841	25	3·95061	70	3·95279
36	3·94626	81	3·94846	26	3·95066	71	3·95284
37	3·94630	82	3·94851	27	3·95071	72	3·95289
38	3·94635	83	3·94856	28	3·95075	73	3·95294
39	3·94640	84	3·94861	29	3·95080	74	3·95299
40	3·94645	85	3·94866	30	3·95085	75	3·95303
41	3·94650	86	3·94871	31	3·95090	76	3·95308
42	3·94655	87	3·94876	32	3·95095	77	3·95313
43	3·94660	88	3·94880	33	3·95100	78	3·95318
44	3·94665	89	3·94885	34	3·95105	79	3·95323
45	3·94670	90	3·94890	35	3·95109	80	3·95328
46	3·94675	91	3·94895	36	3·95114	81	3·95332
47	3·94680	92	3·94900	37	3·95119	82	3·95337
48	3·94685	93	3·94905	38	3·95124	83	3·95342
49	3·94689	94	3·94910	39	3·95129	84	3·95347
50	3·94691	95	3·94915	40	3·95134	85	3·95352
51	3·94699	96	3·94919	41	3·95139	86	3·95357
52	3·94704	97	3·94924	42	3·95143	87	3·95361
53	3·94709	98	3·94929	43	3·95148	88	3·95366
54	3·94714	99	3·94934	44	3·95153	89	3·95371
55	3·94719	8900	3·94939	45	3·95158	90	3·95376
56	3·94724	8901	3·94944	46	3·95163	91	3·95381
57	3·94729	02	3·94949	47	3·95168	92	3·95386
58	3·94734	03	3·91954	48	3·95173	93	3·95390
59	3·94738	04	3·94959	49	3·95177	94	3·95395
60	3·94743	05	3·94963	50	3·95182	95	3·95400
61	3·94748	06	3·94968	51	3·95187	96	3·95405
62	3·94753	07	3·94973	52	3·95192	97	3·95410
63	3·94758	08	3·94978	53	3·95197	98	3·95415
64	3·94763	09	3·94 83	54	3·95202	99	3·95419
65	3·94768	10	3·94988	55	3·95207	9000	3·95424

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
9001	3.95429	9046	3.95646	9091	3.95861	9136	3.96076
02	3.95434	47	3.95650	92	3.95866	37	3.96080
03	3.95439	48	3.95655	93	3.95871	38	3.96085
04	3.95444	49	3.95660	94	3.95875	39	3.96090
05	3.95448	50	3.95665	95	3.95880	40	3.96095
06	3.95453	51	3.95670	96	3.95885	41	3.96099
07	3.95458	52	3.95675	97	3.95890	42	3.96104
08	3.95463	53	3.95679	98	3.95895	43	3.96109
09	3.95468	54	3.95684	99	3.95899	44	3.96114
10	3.95472	55	3.95689	9100	3.95904	45	3.96118
11	3.95477	56	3.95694	9101	3.95909	46	3.96123
12	3.95482	57	3.95698	02	3.95914	47	3.96128
13	3.95487	58	3.95703	03	3.95918	48	3.96133
14	3.95492	59	3.95708	04	3.95923	49	3.96137
15	3.95497	60	3.95713	05	3.95928	50	3.96142
16	3.95501	61	3.95718	06	3.95933	51	3.96147
17	3.95506	62	3.95722	07	3.95938	52	3.96152
18	3.95511	63	3.95727	08	3.95942	53	3.96156
19	3.95516	64	3.95732	09	3.95947	54	3.96161
20	3.95521	65	3.95737	10	3.95952	55	3.96166
21	3.95525	66	3.95742	11	3.95957	56	3.96171
22	3.95530	67	3.95746	12	3.95961	57	3.96175
23	3.95535	68	3.95751	13	3.95966	58	3.96180
24	3.95540	69	3.95756	14	3.95971	59	3.96185
25	3.95545	70	3.95761	15	3.95976	60	3.96190
26	3.95550	71	3.95766	16	3.95980	61	3.96194
27	3.95554	72	3.95770	17	3.95985	62	3.96199
28	3.95559	73	3.95775	18	3.95990	63	3.96204
29	3.95564	74	3.95780	19	3.95995	64	3.96209
30	3.95569	75	3.95785	20	3.95999	65	3.96213
31	3.95574	76	3.95789	21	3.96004	66	3.96218
32	3.95578	77	3.95794	22	3.96009	67	3.96223
33	3.95583	78	3.95799	23	3.96014	68	3.96227
34	3.95588	79	3.95804	24	3.96019	69	3.96232
35	3.95593	80	3.95809	25	3.96023	70	3.96237
36	3.95598	81	3.95813	26	3.96028	71	3.96242
37	3.95602	82	3.95818	27	3.96033	72	3.96246
38	3.95607	83	3.95823	28	3.96038	73	3.96251
39	3.95612	84	3.95828	29	3.96042	74	3.96256
40	3.95617	85	3.95832	30	3.96047	75	3.96261
41	3.95622	86	3.95837	31	3.96052	76	3.96265
42	3.95626	87	3.95842	32	3.96057	77	3.96270
43	3.95631	88	3.95847	33	3.96061	78	3.96275
44	3.95636	89	3.95852	34	3.96066	79	3.96280
45	3.95641	90	3.95856	35	3.96071	80	3.96284

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
9181	3.96289	9226	3.96501	9271	3.96713	9316	3.96923
82	3.96294	27	3.96506	72	3.96717	17	3.96928
83	3.96298	28	3.96511	73	3.96722	18	3.96932
84	3.96303	29	3.96515	74	3.96727	19	3.96937
85	3.96308	30	3.96520	75	3.96731	20	3.96942
86	3.96313	31	3.96525	76	3.96736	21	3.96946
87	3.96317	32	3.96530	77	3.96741	22	3.96951
88	3.96322	33	3.96534	78	3.96745	23	3.96956
89	3.96327	34	3.96539	79	3.96750	24	3.96960
90	3.96332	35	3.96544	80	3.96755	25	3.96965
91	3.96336	36	3.96548	81	3.96759	26	3.96970
92	3.96341	37	3.96553	82	3.96764	27	3.96974
93	3.96346	38	3.96558	83	3.96769	28	3.96979
94	3.96350	39	3.96563	84	3.96774	29	3.96984
95	3.96355	40	3.96567	85	3.96778	30	3.96988
96	3.96360	41	3.96572	86	3.96783	31	3.96993
97	3.96365	42	3.96577	87	3.96788	32	3.96997
98	3.96369	43	3.96581	88	3.96792	33	3.97002
99	3.96374	44	3.96586	89	3.96797	34	3.97007
9200	3.96379	45	3.96591	90	3.96802	35	3.97011
9201	3.96384	46	3.96595	91	3.96806	36	3.97016
02	3.96388	47	3.96600	92	3.96811	37	3.97021
03	3.96393	48	3.96605	93	3.96816	38	3.97025
04	3.96398	49	3.96609	94	3.96820	39	3.97030
05	3.96402	50	3.96614	95	3.96825	40	3.97035
06	3.96407	51	3.96619	96	3.96830	41	3.97039
07	3.96412	52	3.96624	97	3.96834	42	3.97044
08	3.96417	53	3.96628	98	3.96839	43	3.97049
09	3.96421	54	3.96633	99	3.96844	44	3.97053
10	3.96426	55	3.96638	9300	3.96848	45	3.97058
11	3.96431	56	3.96642	9301	3.96853	46	3.97063
12	3.96435	57	3.96647	02	3.96858	47	3.97067
13	3.96440	58	3.96652	03	3.96862	48	3.97072
14	3.96445	59	3.96656	04	3.96867	49	3.97077
15	3.96450	60	3.96661	05	3.96872	50	3.97081
16	3.96454	61	3.96666	06	3.96876	51	3.97086
17	3.96459	62	3.96670	07	3.96881	52	3.97090
18	3.96464	63	3.96675	08	3.96886	53	3.97095
19	3.96468	64	3.96680	09	3.96890	54	3.97100
20	3.96473	65	3.96685	10	3.96895	55	3.97104
21	3.96478	66	3.96689	11	3.96900	56	3.97109
22	3.96483	67	3.96694	12	3.96904	57	3.97114
23	3.96487	68	3.96699	13	3.96909	58	3.97118
24	3.96492	69	3.96703	14	3.96914	59	3.97123
25	3.96497	70	3.96708	15	3.96918	60	3.97128

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
9361	3·97132	9406	3·97341	9451	3·97548	9496	3·97754
62	3·97137	07	3·97345	52	3·97552	97	3·97759
63	3·97142	08	3·97350	53	3·97557	98	3·97763
64	3·97146	09	3·97355	54	3·97562	99	3·97768
65	3·97151	10	3·97359	55	3·97566	9500	3·97772
66	3·97155	11	3·97364	56	3·97571	9501	3·97777
67	3·97160	12	3·97368	57	3·97575	02	3·97782
68	3·97165	13	3·97373	58	3·97580	03	3·97786
69	3·97169	14	3·97377	59	3·97585	04	3·97791
70	3·97174	15	3·97382	60	3·97589	05	3·97795
71	3·97179	16	3·97387	61	3·97594	06	3·97800
72	3·97183	17	3·97391	62	3·97598	07	3·97804
73	3·97188	18	3·97396	63	3·97603	08	3·97809
74	3·97192	19	3·97400	64	3·97607	09	3·97813
75	3·97197	20	3·97405	65	3·97612	10	3·97818
76	3·97202	21	3·97410	66	3·97617	11	3·97823
77	3·97206	22	3·97414	67	3·97621	12	3·97827
78	3·97211	23	3·97419	68	3·97626	13	3·97832
79	3·97216	24	3·97424	69	3·97630	14	3·97836
80	3·97220	25	3·97428	70	3·97635	15	3·97841
81	3·97225	26	3·97433	71	3·97640	16	3·97845
82	3·97230	27	3·97437	72	3·97644	17	3·97850
83	3·97234	28	3·97442	73	3·97649	18	3·97855
84	3·97239	29	3·97447	74	3·97653	19	3·97859
85	3·97243	30	3·97451	75	3·97658	20	3·97864
86	3·97248	31	3·97456	76	3·97663	21	3·97868
87	3·97253	32	3·97460	77	3·97667	22	3·97873
88	3·97257	33	3·97465	78	3·97672	23	3·97877
89	3·97262	34	3·97470	79	3·97676	24	3·97882
90	3·97267	35	3·97475	80	3·97681	25	3·97887
91	3·97271	36	3·97479	81	3·97685	26	3·97891
92	3·97276	37	3·97483	82	3·97690	27	3·97896
93	3·97280	38	3·97488	83	3·97695	28	3·97900
94	3·97285	39	3·97493	84	3·97699	29	3·97905
95	3·97290	40	3·97497	85	3·97704	30	3·97909
96	3·97294	41	3·97502	86	3·97708	31	3·97914
97	3·97299	42	3·97506	87	3·97713	32	3·97918
98	3·97304	43	3·97511	88	3·97717	33	3·97923
99	3·97308	44	3·97516	89	3·97722	34	3·97928
9400	3·97313	45	3·97521	90	3·97727	35	3·97932
9401	3·97317	46	3·97525	91	3·97731	36	3·97937
02	3·97322	47	3·97529	92	3·97736	37	3·97941
03	3·97327	48	3·97534	93	3·97740	38	3·97946
04	3·97331	49	3·97539	94	3·97745	39	3·97950
05	3·97336	50	3·97543	95	3·97750	40	3·97955

N.	Logar.	N.	Logar.	N.	Logar.	N.	Logar.
9541	3.97959	9586	3.98164	9631	3.98367	9676	3.98570
42	3.97964	87	3.98168	32	3.98372	77	3.98574
43	3.97968	88	3.98173	33	3.98376	78	3.98579
44	3.97973	89	3.98177	34	3.98381	79	3.98583
45	3.97978	90	3.98182	35	3.98385	80	3.98588
46	3.97982	91	3.98186	36	3.98390	81	3.98592
47	3.97987	92	3.98191	37	3.98394	82	3.98597
48	3.97991	93	3.98195	38	3.98399	83	3.98601
49	3.97996	94	3.98200	39	3.98403	84	3.98605
50	3.98000	95	3.98205	40	3.98408	85	3.98610
51	3.98005	96	3.98209	41	3.98412	86	3.98614
52	3.98009	97	3.98214	42	3.98417	87	3.98619
53	3.98014	98	3.98218	43	3.98421	88	3.98623
54	3.98019	99	3.98223	44	3.98426	89	3.98628
55	3.98023	9600	3.98227	45	3.98430	90	3.98632
56	3.98028	9601	3.98232	46	3.98435	91	3.98637
57	3.98032	02	3.98236	47	3.98439	92	3.98641
58	3.98037	03	3.98241	48	3.98444	93	3.98646
59	3.98041	04	3.98245	49	3.98448	94	3.98650
60	3.98046	05	3.98250	50	3.98453	95	3.98655
61	3.98050	06	3.98254	51	3.98457	96	3.98659
62	3.98055	07	3.98259	52	3.98462	97	3.98664
63	3.98059	08	3.98263	53	3.98466	98	3.98668
64	3.98064	09	3.98268	54	3.98471	99	3.98673
65	3.98069	10	3.98272	55	3.98475	9700	3.98677
66	3.98073	11	3.98277	56	3.98480	9701	3.98682
67	3.98078	12	3.98281	57	3.98484	02	3.98686
68	3.98082	13	3.98286	58	3.98489	03	3.98691
69	3.98087	14	3.98290	59	3.98493	04	3.98695
70	3.98091	15	3.98295	60	3.98498	05	3.98700
71	3.98096	16	3.98299	61	3.98502	06	3.98704
72	3.98100	17	3.98304	62	3.98507	07	3.98709
73	3.98105	18	3.98308	63	3.98511	08	3.98713
74	3.98109	19	3.98313	64	3.98516	09	3.98717
75	3.98114	20	3.98318	65	3.98520	10	3.98722
76	3.98118	21	3.98322	66	3.98525	11	3.98726
77	3.98123	22	3.98327	67	3.98529	12	3.98731
78	3.98127	23	3.98331	68	3.98534	13	3.98735
79	3.98132	24	3.98336	69	3.98538	14	3.98740
80	3.98137	25	3.98340	70	3.98543	15	3.98744
81	3.98141	26	3.98345	71	3.98547	16	3.98749
82	3.98146	27	3.98349	72	3.98552	17	3.98753
83	3.98150	28	3.98354	73	3.98556	18	3.98758
84	3.98155	29	3.98358	74	3.98561	19	3.98762
85	3.98160	30	3.98363	75	3.98565	20	3.98767

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
9721	3.98771	9766	3.98972	9811	3.99171	9856	3.99370
22	3.98776	67	3.98976	12	3.99176	57	3.99374
23	3.98780	68	3.98981	13	3.99180	58	3.99379
24	3.98784	69	3.98985	14	3.99185	59	3.99383
25	3.98789	70	3.98989	15	3.99189	60	3.99388
26	3.98793	71	3.98994	16	3.99193	61	3.99392
27	3.98798	72	3.98998	17	3.99198	62	3.99397
28	3.98802	73	3.99003	18	3.99202	63	3.99401
29	3.98807	74	3.99007	19	3.99207	64	3.99405
30	3.98811	75	3.99012	20	3.99211	65	3.99410
31	3.98816	76	3.99016	21	3.99216	66	3.99414
32	3.98820	77	3.99021	22	3.99220	67	3.99419
33	3.98825	78	3.99025	23	3.99224	68	3.99423
34	3.98829	79	3.99029	24	3.99229	69	3.99427
35	3.98834	80	3.99034	25	3.99233	70	3.99432
36	3.98838	81	3.99038	26	3.99238	71	3.99436
37	3.98843	82	3.99043	27	3.99242	72	3.99441
38	3.98847	83	3.99047	28	3.99247	73	3.99445
39	3.98851	84	3.99052	29	3.99251	74	3.99449
40	3.98856	85	3.99056	30	3.99255	75	3.99454
41	3.98860	86	3.99061	31	3.99260	76	3.99458
42	3.98865	87	3.99065	32	3.99264	77	3.99463
43	3.98869	88	3.99069	33	3.99269	78	3.99467
44	3.98874	89	3.99074	34	3.99273	79	3.99471
45	3.98878	90	3.99078	35	3.99277	80	3.99476
46	3.98883	91	3.99083	36	3.99282	81	3.99480
47	3.98887	92	3.99087	37	3.99286	82	3.99484
48	3.98892	93	3.99092	38	3.99291	83	3.99489
49	3.98896	94	3.99096	39	3.99295	84	3.99493
50	3.98900	95	3.99100	40	3.99300	85	3.99498
51	3.98905	96	3.99105	41	3.99304	86	3.99502
52	3.98909	97	3.99109	42	3.99308	87	3.99506
53	3.98914	98	3.99114	43	3.99313	88	3.99511
54	3.98918	99	3.99118	44	3.99317	89	3.99515
55	3.98922	9800	3.99123	45	3.99322	90	3.99520
56	3.98927	9801	3.99127	46	3.99326	91	3.99524
57	3.98932	02	3.99131	47	3.99330	92	3.99528
58	3.98936	03	3.99136	48	3.99335	93	3.99533
59	3.98941	04	3.99140	49	3.99339	94	3.99537
60	3.98945	05	3.99145	50	3.99344	95	3.99542
61	3.98949	06	3.99149	51	3.99348	96	3.99546
62	3.98954	07	3.99154	52	3.99352	97	3.99550
63	3.98958	08	3.99158	53	3.99357	98	3.99555
64	3.98963	09	3.99162	54	3.99361	99	3.99559
65	3.98967	10	3.99167	55	3.99366	9900	3.99564

N.	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*	*N.*	*Logar.*
9901	3·99568	9926	3·99677	9951	3·99787	9976	3·99896
02	3·99572	27	3·99682	52	3·99791	77	3·99900
03	3·99577	28	3·99686	53	3·99795	78	3·99904
04	3·99581	29	3·99691	54	3·99800	79	3·99909
05	3·99585	30	3·99695	55	3·99804	80	3·99913
06	3·99590	31	3·99699	56	3·99808	81	3·99917
07	3·99594	32	3·99704	57	3·99813	82	3·99922
08	3·99599	33	3·99708	58	3·99817	83	3·99926
09	3·99603	34	3·99712	59	3·99822	84	3·99930
10	3·99607	35	3·99717	60	3·99826	85	3·99935
11	3·99612	36	3·99721	61	3·99830	86	3·99939
12	3·99616	37	3·99726	62	3·99835	87	3·99944
13	3·99621	38	3·99730	63	3·99839	88	3·99948
14	3·99625	39	3·99734	64	3·99843	89	3·99952
15	3·99629	40	3,99739	65	3·99848	90	3·99957
16	3·99634	41	3·99743	66	3·99852	91	3·99961
17	3·99638	42	3·99747	67	3·99856	92	3 99965
18	3·99642	43	3·99752	68	3·99861	93	3·99970
19	3·99647	44	3·99756	69	3·99865	94	3·99974
20	3,99651	45	3·99760	70	3·99870	95	3·99978
21	3·99656	46	3·99765	71	3·99874	96	3·99983
22	3·99660	47	3·99769	72	3·99878	97	3·99987
23	3·99664	48	3·99774	73	3·99883	98	3·99991
24	3·99669	49	3·99778	74	3·99887	99	3·99996
25	3·99673	50	3·99782	75	3·99891	10000	4·00000

A TABLE

A
TABLE
OF
Artificial SINES, TANGENTS, and SECANTS, the Radius 10.00000; and to every Degree and Minute of the QUADRANT.

A Table of Artificial Sines,

o *Degree.*

Min.	Sine.		Tang.		Secant.		
0	0.00000	10.00000	0.00000	Infinite.	10.00000	Infinite.	60
1	6.46373	9.99999	6.46373	13.53627	10.00000	13.53627	59
2	6.76476	9.99999	6.76476	13.23524	10.00000	13.23524	58
3	6.94085	9.99999	6.94085	13.05915	10.00000	13.05915	57
4	7.06579	9.99999	7.06579	12.93421	10.00000	12.93421	56
5	7.16270	9.99999	7.16270	12.83730	10.00000	12.83730	55
6	7.24188	9.99999	7.24188	12.75812	10.00000	12.75812	54
7	7.30882	9.99999	7.30883	12.69118	10.00000	12.69118	53
8	7.36682	9.99999	7.36682	12.63318	10.00000	12.63318	52
9	7.41797	9.99999	7.41797	12.58203	10.00000	12.58203	51
10	7.46373	9.99999	7.46373	12.53627	10.00000	12.53627	50
11	7.50512	9.99999	7.50512	12.49488	10.00000	12.49488	49
12	7.54291	9.99999	7.54291	12.45709	10.00000	12.45709	48
13	7.57767	9.99999	7.57767	12.42233	10.00000	12.42233	47
14	7.60985	9.99999	7.60986	12.39014	10.00000	12.39015	46
15	7.63982	9.99999	7.63982	12.36018	10.00000	12.36018	45
16	7.66784	9.99999	7.66785	12.33215	10.00001	12.33216	44
17	7.69417	9.99999	7.69418	12.30582	10.00001	12.30583	43
18	7.71900	9.99999	7.71900	12.28100	10.00001	12.28100	42
19	7.74248	9.99999	7.74248	12.25752	10.00001	12.25752	41
20	7.76475	9.99999	7.76476	12.23524	10.00001	12.23525	40
21	7.78594	9.99999	7.78595	12.21405	10.00001	12.21406	39
22	7.80615	9.99999	7.80616	12.19385	10.00001	12.19385	38
23	7.82545	9.99999	7.82546	12.17454	10.00001	12.17455	37
24	7.84393	9.99999	7.84394	12.15606	10.00001	12.15607	36
25	7.86166	9.99999	7.86167	12.13833	10.00001	12.13834	35
26	7.87870	9.99999	7.87871	12.12129	10.00001	12.12130	34
27	7.89509	9.99999	7.89510	12.10490	10.00001	12.10491	33
28	7.91088	9.99999	7.91089	12.08911	10.00001	12.08912	32
29	7.92612	9.99998	7.92613	12.07387	10.00002	12.07388	31
30	7.94084	9.99998	7.94086	12.05914	10.00002	12.05916	30
		Sine.		Tang.		Secant.	Min.

88 *Degrees.*

Tangents, and Secants.

0 *Degree.*

Min.	Sine.		Tang.		Secant.		
30	7.94084	9.99998	7.94086	12.05914	10.00002	12.05916	30
31	7.95508	9.99998	7.95510	12.04490	10.00002	12.04492	29
32	7.96887	9.99998	7.96889	12.03111	10.00002	12.03113	28
33	7.98223	9.99998	7.98225	12.01775	10.00002	12.01777	27
34	7.99520	9.99998	7.99522	12.00478	10.00002	12.00480	26
35	8.00779	9.99998	8.00781	11.99219	10.00002	11.99221	25
36	8.02002	9.99998	8.02004	11.97996	10.00002	11.97998	24
37	8.03192	9.99998	8.03195	11.96806	10.00003	11.96808	23
38	8.04350	9.99997	8.04353	11.95647	10.00003	11.95650	22
39	8.05478	9.99997	8.05481	11.94519	10.00003	11.94522	21
40	8.06578	9.99997	8.06581	11.93419	10.00003	11.93422	20
41	8.07650	9.99997	8.07653	11.92347	10.00003	11.92350	19
42	8.08697	9.99997	8.08700	11.91300	10.00003	11.91303	18
43	8.09718	9.99997	8.09722	11.90278	10.00003	11.90282	17
44	8.10717	9.99996	8.10720	11.89280	10.00004	11.89283	16
45	8.11693	9.99996	8.11696	11.88304	10.00004	11.88307	15
46	8.12647	9.99996	8.12651	11.87349	10.00004	11.87353	14
47	8.13581	9.99996	8.13585	11.86415	10.00004	11.86419	13
48	8.14495	9.99996	8.14500	11.85500	10.00004	11.85505	12
49	8.15391	9.99996	8.15395	11.84605	10.00004	11.84609	11
50	8.16268	9.99995	8.16273	11.83727	10.00005	11.83732	10
51	8.17128	9.99995	8.17133	11.82867	10.00005	11.82872	9
52	8.17971	9.99995	8.17976	11.82024	10.00005	11.82029	8
53	8.18799	9.99995	8.18804	11.81196	10.00005	11.81201	7
54	8.19610	9.99995	8.19616	11.80384	10.00005	11.80390	6
55	8.20407	9.99994	8.20413	11.79587	10.00006	11.79593	5
56	8.21190	9.99994	8.21195	11.78805	10.00006	11.78811	4
57	8.21958	9.99994	8.21964	11.78036	10.00006	11.78042	3
58	8.22713	9.99994	8.22720	11.77281	10.00006	11.77287	2
59	8.23456	9.99994	8.23462	11.76538	10.00006	11.76544	1
60	8.24186	9.99993	8.24192	11.75808	10.00007	11.75815	0
		Sine.		Tang.		Secant.	Min.

89 Degrees.

A Table of Artificial Sines,

1 *Degree.*

Min.	Sine.		Tang.		Secant.		
0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75815	60
1	8.24903	9.99993	8.24910	11.75090	10.00007	11.75097	59
2	8.25609	9.99993	8.25617	11.74384	10.00007	11.74391	58
3	8.26304	9.99993	8.26312	11.73689	10.00007	11.73696	57
4	8.26988	9.99993	8.26996	11.73004	10.00007	11.73012	56
5	8.27661	9.99992	8.27669	11.72331	10.00008	11.72339	55
6	8.28324	9.99992	8.28332	11.71668	10.00008	11.71676	54
7	8.28977	9.99992	8.28986	11.71014	10.00008	11.71023	53
8	8.29621	9.99992	8.29630	11.70371	10.00009	11.70379	52
9	8.30255	9.99991	8.30263	11.69737	10.00009	11.69745	51
10	8.30879	9.99991	8.30888	11.69112	10.00009	11.69121	50
11	8.31495	9.99991	8.31505	11.68495	10.00009	11.68505	49
12	8.32103	9.99991	8.32112	11.67888	10.00010	11.67897	48
13	8.32702	9.99990	8.32711	11.67289	10.00010	11.67298	47
14	8.33292	9.99990	8.33303	11.66698	10.00010	11.66708	46
15	8.33875	9.99990	8.33886	11.66114	10.00010	11.66125	45
16	8.34450	9.99989	8.34461	11.65539	10.00011	11.65550	44
17	8.35018	9.99989	8.35029	11.64971	10.00011	11.64982	43
18	8.35578	9.99989	8.35590	11.64411	10.00011	11.64422	42
19	8.36132	9.99989	8.36143	11.63857	10.00012	11.63869	41
20	8.36678	9.99988	8.36689	11.63311	10.00012	11.63322	40
21	8.37217	9.99988	8.37229	11.62771	10.00012	11.62783	39
22	8.37750	9.99988	8.37762	11.62238	10.00012	11.62250	38
23	8.38276	9.99987	8.38289	11.61711	10.00013	11.61724	37
24	8.38796	9.99987	8.38809	11.61191	10.00013	11.61204	36
25	8.39310	9.99987	8.39323	11.60677	10.00013	11.60690	35
26	8.39818	9.99986	8.39832	11.60169	10.00014	11.60182	34
27	8.40320	9.99986	8.40334	11.59666	10.00014	11.59680	33
28	8.40816	9.99986	8.40830	11.59170	10.00014	11.59184	32
29	8.41307	9.99985	8.41321	11.58679	10.00015	11.58693	31
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
		Sine.		Tang.		Tang.	Min.

88 *Degrees.*

Tangents, and Secants.

Degree.

Min.	Sine.		Tang.		Secant.		
30	8.41792	9.99985	8.41807	11.58193	10.00015	11.58208	30
31	8.42272	9.99985	8.42287	11.57713	10.00015	11.57728	29
32	8.42746	9.99984	8.42762	11.57238	10.00016	11.57254	28
33	8.43216	9.99984	8.43232	11.56769	10.00016	11.56784	27
34	8.43680	9.99984	8.43696	11.56304	10.00016	11.56320	26
35	8.44139	9.99983	8.44156	11.55844	10.00017	11.55861	25
36	8.44594	9.99983	8.44611	11.55389	10.00017	11.55406	24
37	8.45044	9.99983	8.45061	11.54939	10.00017	11.54956	23
38	8.45489	9.99982	8.45507	11.54493	10.00018	11.54511	22
39	8.45930	9.99982	8.45948	11.54052	10.00018	11.54070	21
40	8.46366	9.99982	8.46385	11.53615	10.00018	11.53634	20
41	8.46799	9.99981	8.46817	11.53183	10.00019	11.53202	19
42	8.47226	9.99981	8.47245	11.52755	10.00019	11.52774	18
43	8.47650	9.99981	8.47669	11.52331	10.00020	11.52350	17
44	8.48069	9.99980	8.48089	11.51911	10.00020	11.51931	16
45	8.48485	9.99980	8.48505	11.51495	10.00020	11.51515	15
46	8.48896	9.99979	8.48917	11.51083	10.00021	11.51104	14
47	8.49304	9.99979	8.49325	11.50675	10.00021	11.50696	13
48	8.49708	9.99979	8.49729	11.50271	10.00021	11.50292	12
49	8.50108	9.99978	8.50130	11.49870	10.00922	11.49892	11
50	8.50505	9.99978	8.50527	11.49473	10.00022	11.49496	10
51	8.50897	9.99977	8.50920	11.49080	10.00023	11.49103	9
52	8.51287	9.99977	8.51310	11.48690	10.00023	11.48713	8
53	8.51673	9.99977	8.51696	11.48304	10.00024	11.48327	7
54	8.52055	9.99976	8.52079	11.47921	10.00024	11.47945	6
55	8.52434	9.99976	8.52459	11.47541	10.00024	11.47566	5
56	8.52810	9.99975	8.52835	11.47165	10.00025	11.47190	4
57	8.53183	9.99975	8.53208	11.46792	10.00025	11.46817	3
58	8.53552	9.99974	8.53578	11.46422	10.00026	11.46448	2
59	8.53919	9.99974	8.53945	11.46055	10.00026	11.46081	1
60	8.54282	9.99974	8.54308	11.45692	10.00027	11.45718	0
		Sine.		Tang.		Secant.	Min.

88 *Degrees.*

A Table of Artificial Sines,

2 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	8.54282	9.99974	8.54308	11.45692	10.00027	11.45718	60
1	8.54642	9.99973	8.54669	11.45331	10.00027	11.45358	59
2	8.55000	9.99973	8.55027	11.44973	10.00027	11.45000	58
3	8.55354	9.99972	8.55382	11.44618	10.00028	11.44646	57
4	8.55705	9.99972	8.55734	11.44266	10.00028	11.44295	56
5	8.56054	9.99971	8.56083	11.43917	10.00029	11.43946	55
6	8.56400	9.99971	8.56429	11.43571	10.00029	11.43600	54
7	8.56743	9.99970	8.56773	11.43227	10.00030	11.43257	53
8	8.57084	9.99970	8.57114	11.42886	10.00030	11.42916	52
9	8.57421	9.99969	8.57452	11.42548	10.00030	11.42579	51
10	8.57757	9.99969	8.57788	11.42212	10.00031	11.42243	50
11	8.58089	9.99968	8.58121	11.41879	10.00032	11.41911	49
12	8.58419	9.99968	8.58451	11.41549	10.00032	11.41581	48
13	8.58747	9.99968	8.58779	11.41221	10.00033	11.41253	47
14	8.59072	9.99967	8.59105	11.40895	10.00033	11.40928	46
15	8.59395	9.99967	8.59428	11.40572	10.00034	11.40605	45
16	8.59715	9.99966	8.59749	11.40251	10.00034	11.40285	44
17	8.60033	9.99966	8.60068	11.39932	10.00035	11.39967	43
18	8.60349	9.99965	8.60344	11.39616	10.00035	11.39651	42
19	8.60662	9.99965	8.60698	11.39302	10.00036	11.39338	41
20	8.60973	9.99964	8.61009	11.38991	10.00036	11.39027	40
21	8.61282	9.99964	8.61319	11.38681	10.00037	11.38718	39
22	8.61589	9.99963	8.61626	11.38374	10.00037	11.38411	38
23	8.61894	9.99962	8.61931	11.38069	10.00038	11.38106	37
24	8.62196	9.99962	8.62234	11.37766	10.00038	11.37804	36
25	8.62497	9.99961	8.62535	11.37465	10.00039	11.37504	35
26	8.62795	9.99961	8.62834	11.37166	10.00039	11.37205	34
27	8.63091	9.99960	8.63131	11.36869	10.00040	11.36909	33
28	8.63385	9.99960	8.63426	11.36574	10.00040	11.36615	32
29	8.63678	9.99959	8.63718	11.36282	10.00041	11.36322	31
30	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
		Sine.		Tang.		Secant.	Min.

87 *Degrees.*

Tangents, and Secants.

2 Degrees.

Min.	Sine.		Tang.		Secant.		
30	8.63968	9.99959	8.64009	11.35991	10.00041	11.36032	30
31	8.64256	9.99958	8.64298	11.35702	10.00042	11.35744	29
32	8.64543	9.99958	8.64585	11.35415	10.00043	11.35458	28
33	8.64827	9.99957	8.64870	11.35130	10.00043	11.35173	27
34	8.65110	9.99956	8.65154	11.34846	10.00044	11.34890	26
35	8.65391	9.99956	8.65435	11.34565	10.00044	11.34609	25
36	8.65670	9.99955	8.65715	11.34285	10.00045	11.34330	24
37	8.65948	9.99955	8.65993	11.34007	10.00045	11.34052	23
38	8.66223	9.99954	8.66269	11.33731	10.00046	11.33777	22
39	8.66497	9.99954	8.66543	11.33457	10.00047	11.33503	21
40	8.66769	9.99953	8.66816	11.33184	10.00047	11.33231	20
41	8.67039	9.99952	8.67087	11.32913	10.00048	11.32961	19
42	8.67308	9.99952	8.67356	11.32644	10.00048	11.32692	18
43	8.67575	9.99951	8.67624	11.32376	10.00049	11.32425	17
44	8.67841	9.99951	8.67890	11.32110	10.00049	11.32160	16
45	8.68104	9.99950	8.68154	11.31846	10.00050	11.31896	15
46	8.68367	9.99949	8.68417	11.31583	10.00051	11.31634	14
47	8.68627	9.99949	8.68678	11.31322	10.00051	11.31373	13
48	8.68886	9.99948	8.68938	11.31062	10.00052	11.31114	12
49	8.69144	9.99948	8.69160	11.30804	10.00053	11.30857	11
50	8.69400	9.99947	8.69453	11.30547	10.00053	11.30600	10
51	8.69654	9.99946	8.69708	11.30292	10.00054	11.30346	9
52	8.69907	9.99946	8.69962	11.30038	10.00054	11.30092	8
53	8.70159	9.99945	8.70214	11.29786	10.00055	11.29841	7
54	8.70409	9.99944	8.70465	11.29535	10.00056	11.29591	6
55	8.70658	9.99944	8.70714	11.29286	10.00056	11.29342	5
56	8.70905	9.99943	8.70962	11.29038	10.00057	11.29095	4
57	8.71154	9.99942	8.71208	11.28792	10.00058	11.28849	3
58	8.71395	9.99942	8.71453	11.28547	10.00058	11.28605	2
59	8.71638	9.99941	8.71697	11.28303	10.00059	11.28362	1
60	8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	0
		Sine.		Tang.		Secant.	Min.

87 Degrees.

A Table of Artificial Sines,

3 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	60
1	8.72120	9.99940	8.72181	11.27819	10.00060	11.27880	59
2	8.72360	9.99939	8.72420	11.27580	10.00061	11.27641	58
3	8.72597	9.99938	8.72659	11.27341	10.00062	11.27403	57
4	8.72834	9.99938	8.72896	11.27104	10.00062	11.27166	56
5	8.73069	9.99937	8.73132	11.26868	10.00063	11.26931	55
6	8.73303	9.99936	8.73366	11.26634	10.00064	11.26698	54
7	8.73535	9.99936	8.73600	11.26400	10.00064	11.26464	53
8	8.73767	9.99935	8.73832	11.26168	10.00065	11.26233	52
9	8.73997	9.99934	8.74063	11.25937	10.00066	11.26003	51
10	8.74226	9.99934	8.74292	11.25708	10.00066	11.25774	50
11	8.74454	9.99933	8.74521	11.25479	10.00067	11.25546	49
12	8.74689	9.99932	8.74748	11.25252	10.00068	11.25320	48
13	8.74906	9.99932	8.74974	11.25026	10.00069	11.25095	47
14	8.75130	9.99931	8.75199	11.24801	10.00069	11.24870	46
15	8.75353	9.99930	8.75423	11.24577	10.00070	11.24647	45
16	8.75575	9.99929	8.75645	11.24355	10.00071	11.24425	44
17	8.75796	9.99929	8.75867	11.24133	10.00071	11.24205	43
18	8.76015	9.99928	8.76087	11.23913	10.00072	11.23985	42
19	8.76234	9.99927	8.76307	11.23694	10.00073	11.23767	41
20	8.76451	9.99927	8.76525	11.23475	10.00074	11.23549	40
21	8.76668	9.99926	8.76742	11.23258	10.00074	11.23332	39
22	8.76883	9.99925	8.76958	11.23042	10.00075	11.23117	38
23	8.77097	9.99924	8.77173	11.22827	10.00076	11.22903	37
24	8.77310	9.99924	8.77387	11.22613	10.00077	11.22690	36
25	8.77522	9.99923	8.77600	11.22401	10.00077	11.22478	35
26	8.77733	9.99922	8.77811	11.22189	10.00078	11.22267	34
27	8.77943	9.99920	8.78022	11.21978	10.00079	11.22057	33
28	8.78152	9.99920	8.78232	11.21768	10.00080	11.21848	32
29	8.78361	9.99920	8.78441	11.21559	10.00080	11.21639	31
30	8.78568	9.99919	8.78640	11.21351	10.00081	11.21432	30
		Sine.		Tang.		Secant.	Min.

86 *Degrees.*

Tangents, and Secants.

3 Degree.

Min.	Sine.		Tang.		Secant.		
30	8.78568	9.99919	8.78649	11.21351	10.00081	11.21433	30
31	8.78774	9.99918	8.78855	11.21145	10.00082	11.21226	29
32	8.78979	9.99917	8.79061	11.20939	10.00083	11.21021	28
33	8.79183	9.99917	8.79266	11.20734	10.00083	11.20817	27
34	8.79386	9.99916	8.79470	11.20530	10.00084	11.20614	26
35	8.79588	9.99915	8.79673	11.20327	10.00085	11.20412	25
36	8.79789	9.99914	8.79875	11.20125	10.00086	11.20211	24
37	8.79990	9.99913	8.80076	11.19924	10.00087	11.20010	23
38	8.80189	9.99913	8.80277	11.19724	10.00087	11.19811	22
39	8.80388	9.99912	8.80476	11.19524	10.00088	11.19612	21
40	8.80585	9.99911	8.80674	11.19326	10.00089	11.19415	20
41	8.80782	9.99910	8.80872	11.19128	10.00090	11.19218	19
42	8.80978	9.99909	8.81068	11.18932	10.00091	11.19022	18
43	8.81173	9.99909	8.81264	11.18736	10.00091	11.18827	17
44	8.81367	9.99908	8.81459	11.18541	10.00092	11.18633	16
45	8.81560	9.99907	8.81653	11.18347	10.00093	11.18440	15
46	8.81752	9.99906	8.81846	11.18154	10.00094	11.18248	14
47	8.81944	9.99905	8.82038	11.17962	10.00095	11.18057	13
48	8.82134	9.99904	8.82230	11.17770	10.00096	11.17860	12
49	8.82324	9.99904	8.82421	11.17580	10.00096	11.17676	11
50	8.82513	9.99903	8.82610	11.17390	10.00097	11.17487	10
51	8.82701	9.99902	8.82799	11.17201	10.00098	11.17299	9
52	8.82888	9.99901	8.82987	11.17013	10.00099	11.17112	8
53	8.83075	9.99900	8.83175	11.16825	10.00100	11.16925	7
54	8.83261	9.99899	8.83361	11.16639	10.00101	11.16739	6
55	8.83446	9.99898	8.83547	11.16453	10.00102	11.16554	5
56	8.83630	9.99898	8.83732	11.16268	10.00102	11.16370	4
57	8.83813	9.99897	8.83916	11.16084	10.00103	11.16187	3
58	8.84996	9.99896	8.84100	11.15900	10.00104	11.16004	2
59	8.84177	9.99895	8.84282	11.15718	10.00105	11.15823	1
60	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	0
		Sine.		Tang.		Secant.	Min.

86 Degrees.

A Table of Artificial Sines,

4 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
1	8.84539	9.99893	8.84646	11.15355	10.00107	11.15461	59
2	8.84718	9.99892	8.84826	11.15174	10.00108	11.15282	58
3	8.84897	9.99891	8.85006	11.14994	10.00109	11.15103	57
4	8.85075	9.99891	8.85185	11.14815	10.00110	11.14923	56
5	8.85252	9.99890	8.85363	11.14637	10.00110	11.14748	55
6	8.85429	9.99889	8.85540	11.14460	10.00111	11.14571	54
7	8.85605	9.99888	8.85717	11.14283	10.00112	11.14395	53
8	8.85780	9.99887	8.85893	11.14107	10.00113	11.14220	52
9	8.85955	9.99886	8.86069	11.13931	10.00114	11.14045	51
10	8.86128	9.99885	8.86243	11.13757	10.00115	11.13872	50
11	8.86301	9.99884	8.86417	11.13583	10.00116	11.13699	49
12	8.86474	9.99883	8.86591	11.13409	10.00117	11.13526	48
13	8.86645	9.99882	8.86763	11.13237	10.00118	11.13355	47
14	8.86817	9.99881	8.86935	11.13065	10.00119	11.13184	46
15	8.86987	9.99880	8.87106	11.12894	10.00120	11.13014	45
16	8.87157	9.99880	8.87277	11.12723	10.00121	11.12844	44
17	8.87326	9.99879	8.87447	11.12553	10.00122	11.12675	43
18	8.87494	9.99878	8.87616	11.12384	10.00122	11.12506	42
19	8.87662	9.99877	8.87785	11.12215	10.00123	11.12339	41
20	8.87829	9.99876	8.87953	11.12047	10.00124	11.12171	40
21	8.87995	9.99875	8.88120	11.11880	10.00125	11.12005	39
22	8.88161	9.99874	8.88287	11.11713	10.00126	11.11839	38
23	8.88326	9.99873	8.88453	11.11547	10.00127	11.11674	37
24	8.88490	9.99872	8.88619	11.11382	10.00128	11.11510	36
25	8.88654	9.99871	8.88783	11.11217	10.00129	11.11346	35
26	8.88817	9.99870	8.88948	11.11052	10.00130	11.11183	34
27	8.88980	9.99869	8.89111	11.10889	10.00131	11.11020	33
28	8.89142	9.99868	8.89274	11.10726	10.00132	11.10858	32
29	8.89304	9.99867	8.89437	11.10563	10.00133	11.10697	31
30	8.89464	9.99866	8.89598	11.10402	10.00134	11.10536	30
		Sine.		Tang.		Secant.	Min.

85 *Degrees.*

Tangents, and Secants.

4 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	8.89564	9.99866	8.89598	11.10402	10.00134	11.10536	30
31	8.89625	9.99865	8.89760	11.10240	10.00135	11.10375	29
32	8.89784	9.99864	8.89920	11.10080	10.00136	11.10216	28
33	8.89943	9.99863	8.90080	11.09920	10.00137	11.10057	27
34	8.90102	9.99862	8.90240	11.09769	10.00138	11.09898	26
35	8.90260	9.99861	8.90399	11.09601	10.00130	11.09740	25
36	8.90417	9.99860	8.90557	11.09443	10.00140	11.09583	24
37	8.90574	9.99859	8.90715	11.09285	10.00141	11.09426	23
38	8.90730	9.99858	8.90872	11.09128	10.00142	11.09270	22
39	8.90885	9.99857	8.91029	11.08972	10.00143	11.09115	21
40	8.91040	9.99856	8.91185	11.08815	10.00144	11.08960	20
41	8.91195	9.99855	8.91340	11.08660	10.00145	11.08805	19
42	8.91349	9.99854	8.91495	11.08505	10.00146	11.08651	18
43	8.91502	9.99853	9.91650	11.08351	10.00147	11.08498	17
44	8.91655	9.99852	9.91803	11.08197	10.00148	11.08345	16
45	8.91807	9.99851	9.91957	11.08043	10.00149	11.08193	15
46	8.91959	9.99850	9.92110	11.07890	10.00151	11.08041	14
47	8.92110	9.99849	9.92262	11.07738	10.00152	11.07890	13
43	8.92261	9.99847	9.92414	11.07586	10.00153	11.07739	12
49	8.92411	9.99846	9.92565	11.07434	10.00154	11.07589	11
50	8.92561	9.99845	9.92716	11.07285	10.00155	11.07439	10
51	8.92710	9.99844	9.92866	11.07134	10.00156	11.07290	9
52	8.92859	9.99843	9.92016	11.06985	10.00157	11.07141	8
53	8.93007	9.99842	9.93165	11.06835	10.00158	11.06993	7
54	8.93154	9.99841	9.93313	11.06687	10.00159	11.06846	6
55	8.93302	9.99840	9.93462	11.06538	10.00160	11.06698	5
56	8.93448	9.99839	9.93609	11.06391	10.00161	11.06552	4
57	8.93594	9.99838	9.93757	11.06244	10.00162	11.06406	3
53	8.93740	9.99837	9.93903	11.06097	10.00163	11.06260	2
59	8.93885	9.99836	9.94049	11.05951	10.00165	11.06115	1
60	8.94030	9.99834	9.94195	11.05805	10.00166	11.05970	0
		Sine.		Tang.		Secant.	Min.

85 *Degrees.*

A Table of Artificial Sines,

5 Degree.

Min.	Sine.		Tang.		Secant.		
0	8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	60
1	8.94174	9.99833	8.94340	11.05660	10.00167	11.05826	59
2	8.94317	9.99832	8.94485	11.05515	10.00168	11.05683	58
3	8.94461	9.99831	8.94630	11.05371	10.00169	11.05539	57
4	8.94603	9.99830	8.94773	11.05227	10.00170	11.05397	56
5	8.94746	9.99829	8.94917	11.05083	10.00171	11.05254	55
6	8.94887	9.99828	8.95060	11.04949	10.00172	11.05113	54
7	8.95029	9.99827	8.95202	11.04798	10.00173	11.04971	53
8	8.95170	9.99826	8.95344	11.04656	10.00175	11.04830	52
9	8.95310	9.99824	8.95486	11.04514	10.00176	11.04690	51
10	8.95450	9.99823	8.95627	11.04373	10.00177	11.04550	50
11	8.95590	9.99822	8.95767	11.04233	10.00178	11.04411	49
12	8.95728	9.99821	8.95908	11.04093	10.00179	11.04272	48
13	8.95867	9.99820	8.96047	11.03953	10.00180	11.04133	47
14	8.96005	9.99819	8.96187	11.03813	10.00181	11.03995	46
15	8.96143	9.99817	8.96325	11.03675	10.00183	11.03857	45
16	8.96280	9.99816	8.96464	11.03536	10.00184	11.03720	44
17	8.96417	9.99815	8.96602	11.03398	10.00185	11.03583	43
18	8.96553	9.99814	8.96739	11.03261	10.00186	11.03447	42
19	8.96689	9.99813	8.96877	11.03123	10.00187	11.03311	41
20	8.96825	9.99812	8.97013	11.02987	10.00188	11.03175	40
21	8.96960	9.99810	8.97150	11.02850	10.00190	11.03040	39
22	8.97095	9.99809	8.97286	11.02715	10.00191	11.03905	38
23	8.9722	9.99808	8.97421	11.02579	10.00192	11.02771	37
24	8.97363	9.99807	8.97556	11.02444	10.00193	11.02637	36
25	8.97496	9.99806	8.97691	11.02309	10.00194	11.02504	35
26	8.97629	9.99804	8.97825	11.02175	10.00196	11.02371	34
27	8.97762	9.99803	8.97959	11.02041	10.00197	11.02238	33
28	8.97894	9.99802	8.98092	11.01908	10.00198	11.02106	32
29	8.98026	9 99801	8.98225	11.01775	10.00199	11.01974	31
30	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
		Sine.		Tang.		Secant.	Min.

84 Degrees.

Tangents, and Secants.

5 Degrees.

Min.	Sine.		Tang.		Secant.		
30	8.98157	9.99800	8.98358	11.01642	10.00200	11.01843	30
31	8.98288	9.99798	8.98490	11.01510	10.00202	11.01712	29
32	8.98419	9.99797	8.98622	11.01378	10.00203	11.01581	28
33	8.98549	9.99796	8.98753	11.01247	10.00204	11.01451	27
34	8.98679	9.99795	8.98884	11.01116	10.00205	11.01321	26
35	8.98808	9.99794	8.99015	11.00985	10.00207	11.01192	25
36	8.98937	9.99792	8.99145	11.00855	10.00208	11.01063	24
37	8.99066	9.99791	8.99275	11.00725	10.00209	11.00934	23
38	8.99194	9.99790	8.99405	11.00596	10.00210	11.00806	22
39	8.99322	9.99789	8.99534	11.00466	10.00212	11.00678	21
40	8.99450	9.99787	8.99662	11.00338	10.00213	11.00550	20
41	8.99577	9.99786	8.99791	11.00209	10.00214	11.00423	19
42	8.99704	9.99785	8.99919	11.00081	10.00215	11.00296	18
43	8.99830	9.99784	9.00047	10.99954	10.00217	11.00170	17
44	8.99956	9.99782	9.00174	10.99826	10.00218	11.00044	16
45	9.00082	9.99781	9.00301	10.99699	10.00220	10.99918	15
46	9.00207	9.99780	9.00427	10.99573	10.00221	10.99793	14
47	9.00332	9.99778	9.00553	10.99447	10.00222	10.99668	13
43	9.00456	9.99777	9.00679	10.99321	10.00223	10.99544	12
49	9.00581	9.99776	9.00805	10.99195	10.00224	10.99420	11
50	9.00704	9.99775	9.00930	10.99070	10.00226	10.99296	10
51	9.00828	9.99773	9.01055	10.98945	10.00227	10.99172	9
52	9.00951	9.99772	9.01179	10.98821	10.00228	10.99049	8
53	9.01074	9.99771	9.01303	10.98697	10.00229	10.98926	7
54	9.01196	9.99769	9.01427	10.98573	10.00231	10.98804	6
55	9.01318	9.99768	9.01550	10.98450	10.00232	10.98682	5
56	9.01440	9.99767	9.01673	10.98327	10.00233	10.98560	4
57	9.01561	9.99765	9.01796	10.98204	10.00235	10.98439	3
53	9.01682	9.99764	9.01918	10.98082	10.00236	10.98318	2
59	9.01803	9.99763	9.02040	10.97960	10.00237	10.98197	1
60	9.01923	9.99761	9.02162	10.97838	10.00239	10.98077	0
		Sine.		Tang.		Secant.	Min.

84 Degrees.

A Table of Artificial Sines,

6 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.01924	9.99761	9.02162	10.97838	10.00239	10.98077	60
1	9.02044	9.99760	9.02283	10.97717	10.00240	10.97957	59
2	9.02163	9.99759	9.02404	10.97596	10.00241	10.97837	58
3	9.02283	9.99757	9.02525	10.97475	10.00243	10.97718	57
4	9.02402	9.99756	9.02646	10.97355	10.00244	10.97598	56
5	9.02520	9.99755	9.02766	10.97235	10.00245	10.97480	55
6	9.02639	9.99753	9.02885	10.97115	10.00247	10.97361	54
7	9.02757	9.99752	9.03005	10.96995	10.00248	10.97243	53
8	9.02874	9.99751	9.03124	10.96876	10.00249	10.97126	52
9	9.02992	9.99749	9.03243	10.96758	10.00251	10.97008	51
10	9.03109	9.99748	9.03361	10.96639	10.00252	10.96891	50
11	9.03226	9.99747	9.03479	10.96521	10.00253	10.96774	49
12	9.03342	9.99745	9.03597	10.96403	10.00255	10.96658	48
13	9.03458	9.99744	9.03714	10.96286	10.00256	10.96542	47
14	9.03574	9.99743	9.03832	10.96168	10.00258	10.96426	46
15	9.03690	9.99741	9.03949	10.96052	10.00259	10.96310	45
16	9.03805	9.99740	9.04065	10.95935	10.00260	10.96195	44
17	9.03920	9.99738	9.04181	10.95819	10.00262	10.96080	43
18	9.04034	9.99737	9.04297	10.95703	10.00263	10.95966	42
19	9.04149	9.99736	9.04413	10.95587	10.00265	10.95852	41
20	9.04263	9.99734	9.04528	10.96472	10.00266	10.95738	40
21	9.04376	9.99733	9.04643	10.95357	10.00267	10.95624	39
22	9.04490	9.99731	9.04758	10.95242	10.00269	10.95511	38
23	9.04603	9.99730	9.04873	10.95127	10.00270	10.95397	37
24	9.04715	9.99729	9.04987	10.95013	10.00272	10.95285	36
25	9.04828	9.99727	9.05101	10.94899	10.00273	10.95172	35
26	9.04940	9.99726	9.05214	10.94786	10.00274	10.95060	34
27	9.05052	9.99724	9.05328	10.94672	10.00276	10.94948	33
28	9.05164	9.99723	9.05441	10.94559	10.00277	10.94836	32
29	9.05275	9.99721	9.05554	10.94447	10.00279	10.94725	31
30	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
		Sine.		Tang.		Secant.	Min.

83 Degrees.

Tangents, and Secants.

6 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.05386	9.99720	9.05666	10.94334	10.00280	10.94614	30
31	9.05497	9.99719	9.05778	10.94222	10.00282	10.94503	29
32	9.05607	9.99717	9.05890	10.94110	10.00283	10.94393	28
33	9.05717	9.99716	9.06002	10.93998	10.00284	10.94283	27
34	9.05827	9.99714	9.06113	10.93887	10.00286	10.94173	26
35	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
36	9.06046	9.99711	9.06335	10.93665	10.00289	10.93954	24
37	9.06155	9.99710	9.06445	10.93555	10.00290	10.93845	23
38	9.06264	9.99708	9.06556	10.93444	10.00292	10.93736	22
39	9.06372	9.99707	9.06666	10.93335	10.00293	10.93628	21
40	9.06481	9.99705	9.06775	10.93225	10.00295	10.93529	20
41	9.06589	9.99704	9.06885	10.93115	10.00296	10.93412	19
42	9.06696	9.99702	9.06994	10.93006	10.00298	10.93304	18
43	9.06804	9.96701	9.07103	10.92897	10.00299	10.93196	17
44	9.06911	9.99699	9.07211	10.92789	10.00301	10.93089	16
45	9.07018	9.99698	9.07320	10.92680	10.00302	10.92982	15
46	9.07124	9.99696	9.07428	10.92572	10.00304	10.92876	14
47	9.07231	9.99695	9.07536	10.92464	10.00305	10.92769	13
48	9.07337	9.99693	9.07643	10.92357	10.00307	10.92663	12
49	9.07442	9.99692	9.07751	10.92250	10.00308	10.92558	11
50	9.07548	9.99690	9.07858	10.92142	10.00310	10.92452	10
51	9.07653	9.99689	9.07964	10.92036	10.00311	0.92347	9
52	9.07758	9.99687	9.08071	10.91929	10.00313	10.92242	8
53	9.07863	9.99686	9.08177	10.91823	10.00314	10.92137	7
54	9.07968	9.99684	9.08283	10.91717	10.00316	10.92032	6
55	9.08072	9.99683	9.08389	10.91611	10.00317	10.91928	5
56	9.08176	9.99681	9.08495	10.91505	10.00319	10.91824	4
57	9.08280	9.99680	9.08600	10.91400	10.00320	10.91720	3
58	9.08383	9.99678	9.08705	10.91295	10.00322	10.91617	2
59	9.08486	9.99677	9.08810	10.91190	10.00323	10.91514	1
60	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	0
		Sine.		Tang.		Secant.	Min.

83 Degrees.

A Table of Artificial Sines,

7 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
1	9.08692	9.99674	9.09019	10.90981	10.00327	10.91308	59
2	9.08795	9.99672	9.09123	10.90877	10.00328	10.91205	58
3	9.08897	9.99670	9.09227	10.90773	10.00330	10.91103	57
4	9.08999	9.99669	9.09330	10.90670	10.00331	10.91001	56
5	9.09101	9.99667	9.09434	10.90566	10.00333	10.90899	55
6	9.09202	9.99666	9.09537	10.90463	10.00334	10.90798	54
7	9.09304	9.99664	9.09640	10.90360	10.00336	10.90696	53
8	9.09405	9.99663	9.09742	10.90258	10.00338	10.90595	52
9	9.09506	9.99661	9.09845	10.90155	10.00339	10.90494	51
10	9.09606	9.99659	9.09947	10.90053	10.00341	10.90394	50
11	9.09707	9.99658	9.10049	10.89951	10.00342	10.90293	49
12	9.09807	9.99656	9.10150	10.89850	10.00344	10.90193	48
13	9.09907	9.99655	9.10252	10.89748	10.00345	10.90093	47
14	9.10006	9.99653	9.10353	10.89647	10.00347	10.89994	46
15	9.10106	9.99651	9.10454	10.89546	10.00349	10.89894	45
16	9.10205	9.99650	9.10555	10.89445	10.00350	10.89795	44
17	9.10304	9.99648	9.10656	10.89344	10.00352	10.89696	43
18	9.10403	9.99647	9.10756	10.89244	10.00353	10.89597	42
19	9.10501	9.99645	9.10856	10.89144	10.00355	10.89499	41
20	9.10599	9.99643	9.10956	10.89044	10.00357	10.89401	40
21	9.10697	9.99642	9.11056	10.88944	10.00358	10.89303	39
22	9.10795	9.99640	9.11155	10.88845	10.00360	10.89205	38
23	9.10893	9.99638	9.11254	10.88746	10.00362	10.89107	37
24	9.10990	9.99637	9.11353	10.88647	10.00363	10.89010	36
25	9.11087	9.99635	9.11452	10.88548	10.00365	10.88913	35
26	9.11184	9.99634	9.11551	10.88449	10.00367	10.88816	34
27	9.11281	9.99632	9.11649	10.88351	10.00368	10.88719	33
28	9.11377	9.99630	9.11747	10.88253	10.00370	10.88623	32
29	9.11474	9.99629	9.11845	10.88155	10.00372	10.88526	31
30	9.11570	9.99627	9.11943	10.88057	10.00373	10.88430	30
		Sine.		Tang.		Secant.	Min.

82 Degrees.

Tangents, and Secants.

7 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.11570	9.99627	9.12943	10.88057	10.00373	10.88430	30
31	9.11666	9.99625	9.12040	10.87960	10.00375	10.88334	29
32	9.11761	9.99624	9.12138	10.87862	10.00377	10.88239	28
33	9.11857	9.99622	9.12235	10.87765	10.00378	10.88143	27
34	9.11952	9.99620	9.12332	10.87668	10.00380	10.88048	26
35	9.12047	9.99619	9.12428	10.87572	10.00382	10.87953	25
36	9.12142	9.99617	9.12525	10.87475	10.00383	10.87858	24
37	9.12236	9.99615	9.12620	10.87379	10.00385	10.87764	23
38	9.12331	9.99613	9.12717	10.87283	10.00387	10.87669	22
39	9.12425	9.99612	9.12813	10.87187	10.00388	10.87575	21
40	9.12519	9.99610	9.12909	10.87091	10.00390	10.87481	20
41	9.12612	9.99608	9.13004	10.86996	10.00392	10.87388	19
42	9.12706	9.99607	9.13099	10.86901	10.00393	10.87294	18
43	9.12799	9.96605	9.13194	10.86806	10.00395	10.87201	17
44	9.12893	9.99603	9.13289	10.86711	10.00397	10.87108	16
45	9.12985	9.99602	9.13384	10.86616	10.00399	10.87015	15
46	9.13078	9.99600	9.13478	10.86522	10.00400	10.86922	14
47	9.13171	9.99598	9.13573	10.86427	10.00402	10.86829	13
48	9.13263	9.99596	9.13667	10.86333	10.00404	10.86737	12
49	9.13355	9.99595	9.13761	10.86240	10.00405	10.86645	11
50	9.13447	9.99593	9.13854	10.86146	10.00407	10.86553	10
51	9.13539	9.99591	9.13948	10.86052	10.00409	10.86461	9
52	9.13630	9.99589	9.14041	10.85959	10.00411	10.86370	8
53	9.13722	9.99588	9.14134	10.85866	10.00412	10.86278	7
54	9.13813	9.99586	9.14227	10.85773	10.00414	10.86187	6
55	9.13904	9.99584	9.14320	10.85680	10.00416	10.86096	5
56	9.13994	9.99582	9.14412	10.85588	10.00418	10.86006	4
57	9.14085	9.99581	9.14504	10.85496	10.00419	10.85915	3
58	9.14175	9.99579	9.14597	10.85403	10.00421	10.85825	2
59	9.14266	9.99577	9.14689	10.85312	10.00423	10.85734	1
60	9.14356	9.99575	9.14780	10.85220	10.00425	10.85645	0
		Sine.		Tang.		Secant.	Min.

82 *Degrees.*

A Table of Artificial Sines,

8 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.14356	9.99575	9.14780	10.85220	10.00425	10.85645	60
1	9.14445	9.99574	9.14872	10.85128	10.00427	10.85555	59
2	9.14535	9.99572	9.14963	10.85037	10.00428	10.85465	58
3	9.14624	9.99570	9.15054	10.84946	10.00430	10.85376	57
4	9.14714	9.99568	9.15145	10.84855	10.00432	10.85286	56
5	9.14803	9.99566	9.15236	10.84764	10.00434	10.85197	55
6	9.14892	9.99565	9.15327	10.84673	10.00435	10.85109	54
7	9.14980	9.99563	9.15417	10.84583	10.00437	10.85020	53
8	9.15069	9.99561	9.15508	10.84492	10.00439	10.84931	52
9	9.15157	9.99559	9.15598	10.84402	10.00441	10.84843	51
10	9.15245	9.99557	9.15688	10.84312	10.00443	10.84755	50
11	9.15333	9.99556	9.15778	10.84223	10.00445	10.84667	49
12	9.15421	9.99554	9.15867	10.84133	10.00446	10.84579	48
13	9.15508	9.99552	9.15957	10.84044	10.00448	10.84492	47
14	9.15596	9.99550	9.16046	10.83954	10.00450	10.84404	46
15	9.15683	9 99548	9.16135	10.83865	10.00452	10.84317	45
16	9.15770	9.99546	9.16224	10.83776	10.00454	10.84230	44
17	9.15857	9.99545	9.16312	10.83688	10.00455	10.84143	43
18	9.15944	9.99543	9.16401	10.83599	10.00457	10.84057	42
19	9.16030	9.99541	9.16489	10.83511	10.00459	10.83970	41
20	9.16116	9.99539	9.16577	10.83423	10.00461	10.83884	40
21	9.16203	9.99537	9.16665	10.83335	10.00463	10.83797	39
22	9.16289	9.99535	9.16753	10.83247	10.00465	10.83712	38
23	9.16374	9.99533	9.16850	10.83159	10.00467	10.83626	37
24	9.16460	9.99532	9.16928	10.83072	10.00468	10.83540	36
25	9.16545	9 99530	9.17016	10.82984	10.00470	10.83455	35
26	9.16631	9 99528	9.17103	10.82897	10 00472	10.83369	34
27	9.16716	9.99526	9.17190	10.82810	10.00474	10.83284	33
28	9.16801	9 99524	9.17277	10 82723	10.00476	10.83199	32
29	9.16886	9.99522	9.17363	10.82637	10.00478	10.83114	31
30	9.16970	9.99520	9.17450	10.82550	10.00480	10.83030	30
		Sine.		Tang.		Secant.	Min.

81 Degrees.

Tangents, and Secants.

8 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.16970	9.99520	9.17450	10.82550	10.00480	10.83030	30
31	9.17055	9.99518	9.17536	10.82464	10.00482	10.82945	29
32	9.17139	9.99517	9.17622	10.82378	10.00484	10.82861	28
33	9.17223	9.99515	9.17708	10.82292	10.00485	10.82777	27
34	9.17307	9.99513	9.17794	10.82206	10.00487	10.82693	26
35	9.17391	9.99511	9.17880	10.82120	10.00489	10.82609	25
36	9.17474	9.99509	9.17966	10.82035	10.00491	10.82526	24
37	9.17558	9.99507	9.18051	10.81949	10.00493	10.82442	23
38	9.17641	9.99505	9.18136	10.81864	10.00495	10.82359	22
39	9.17724	9.99503	9.18221	10.81779	10.00497	10.82276	21
40	9.17807	9.99501	9.18306	10.81694	10.00499	10.82193	20
41	9.17890	9.99499	9.18391	10.81609	10.00501	10.82111	19
42	9.17973	9.99497	9.18475	10.81525	10.00503	10.82027	18
43	9.18055	9.99496	9.18560	10.81440	10.00505	10.81945	17
44	9.18137	9.99494	9.18644	10.81356	10.00507	10.81863	16
45	9.18220	9.99492	9.18728	10.81272	10.00508	10.81780	15
46	9.18302	9.99490	9.18812	10.81188	10.00510	10.81698	14
47	9.18383	9.99488	9.18896	10.81104	10.00512	10.81617	13
48	9.18465	9.99486	9.18979	10.81021	10.00514	10.81535	12
49	9.18547	9.99484	9.19063	10.80937	10.00516	10.81453	11
50	9.18628	9.99482	9.19146	10.80854	10.00518	10.81372	10
51	9.18709	9.99480	9.19229	10.80771	10.00520	10.81291	9
52	9.18790	9.99478	9.19312	10.80688	10.00522	10.81210	8
53	9.18871	9.99476	9.19395	10.80605	10.00524	10.81129	7
54	9.18952	9.99474	9.19478	10.80522	10.00526	10.81048	6
55	9.19033	9.99472	9.19561	10.80439	10.00528	10.80968	5
56	9.19113	9.99470	9.19643	10.80357	10.00530	10.80887	4
57	9.19193	9.99468	9.19725	10.80275	10.00532	10.80807	3
58	9.19273	9.99466	9.19807	10.80193	10.00534	10.80727	2
59	9.19353	9.99464	9.19889	10.80111	10.00536	10.80647	1
60	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	0
		Sine.		Tang.		Secant.	Min.

81 *Degrees.*

A Table of Artificial Sines,

9 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
1	9.19513	9.99460	9.20053	10.79947	10.00540	10.80487	59
2	9.19593	9.99458	9.20135	10.79866	10.00542	10.80408	58
3	9.19672	9.99456	9.20216	10.79784	10.00544	10.80328	57
4	9.19751	9.99454	9.20297	10.79703	10.00546	10.80249	56
5	9.19830	9.99452	9.20378	10.79622	10.00548	10.80170	55
6	9.19909	9.99450	9.20459	10.79541	10.00550	10.80091	54
7	9.19988	9.99448	9.20540	10.79460	10.00552	10.80012	53
8	9.20067	9.99446	9.20621	10.79379	10.00554	10.79933	52
9	9.20145	9.99444	9.20701	10.79299	10.00556	10.79855	51
10	9.20223	9.99442	9.20782	10.79218	10.00558	10.79777	50
11	9.20302	9.99440	9.20862	10.79138	10.00560	10.79698	49
12	9.20380	9.99438	9.20942	10.79058	10.00562	10.79620	48
13	9.20458	9.99436	9.21022	10.78978	10.00564	10.79542	47
14	9.20535	9.99434	9.21102	10.78898	10.00566	10.79465	46
15	9.20613	9.99432	9.21182	10.78819	10.00568	10.79387	45
16	9.20691	9.99430	9.21261	10.78739	10.00571	10.79309	44
17	9.20768	9.99427	9.21341	10.78660	10.00572	10.79232	43
18	9.20845	9.99425	9.21420	10.78580	10.00575	10.79155	42
19	9.20922	9.99423	9.21499	10.78501	10.00577	10.79078	41
20	9.20999	9.99421	9.21578	10.78422	10.00579	10.79001	40
21	9.21076	9.99419	9.21657	10.78343	10.00581	10.78924	39
22	9.21153	9.99417	9.21736	10.78264	10.00583	10.78847	38
23	9.21229	9.99415	9.21814	10.78186	10.00585	10.78771	37
24	9.21306	9.99413	9.21893	16.78107	10.00587	10.78695	36
25	9.21382	9.99411	9.21971	10.78029	10.00589	10.78618	35
26	9.21458	9.99409	9.22049	10.77951	10.00591	10.78542	34
27	9.21534	9.99407	9.22127	10.77873	10.00593	10.78466	33
28	9.21610	9.99405	9.22205	10.77795	10.00596	10.78390	32
29	9.21685	9.99462	9.22283	10.77717	10.00598	10.78315	31
30	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
		Sine.		Tang.		Secant.	Min.

80 Degrees.

Tangents, and Secants.

9 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.21761	9.99400	9.22361	10.77639	10.00600	10.78239	30
31	9.21836	9.99398	9.22438	10.77562	10.00602	10.78164	29
32	9.21912	9.99396	9.22516	10.77484	10.00604	10.78088	28
33	9.21987	9.99394	9.22593	10.77407	10.00606	10.78013	27
34	9.22062	9.99392	9.22670	10.77330	10.00608	10.77938	26
35	9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
36	9.22212	9.99388	9.22824	10.77176	10.00613	10.77789	24
37	9.22286	9.99385	9.22901	10.77099	10.00615	10.77714	23
38	9.22361	9.99383	9.22977	10.77023	10.00617	10.77639	22
39	9.22435	9.99381	9.23054	10.76946	10.00619	10.77565	21
40	9.22509	9.99379	9.23130	10.76870	10.00621	10.77491	20
41	9.22583	9.99377	9.23207	10.76794	10.00623	10.77417	19
42	9.22657	9.99375	9.23283	10.76717	10.00625	10.77343	18
43	9.22731	9.99373	9.23359	10.76641	10.00628	10.77269	17
44	9.22805	9.99370	9.23435	10.76566	10.00630	10.77195	16
45	9.22878	9.99368	9.23510	10.76490	10.00632	10.77122	15
46	9.22952	9.99366	9.23586	10.76414	10.00634	10.77048	14
47	9.23025	9.99364	9.23661	10.76339	10.00636	10.76975	13
48	9.23098	9.99362	9.23737	10.76263	10.00638	10.76902	12
49	9.23171	9.99359	9.23812	10.76188	10.00641	10.76829	11
50	9.23244	9.99357	9.23887	10.76113	10.00643	10.76756	10
51	9.23317	9.99355	9.23962	10.76038	10.00645	10.76683	9
52	9.23390	9.99353	9.24037	10.75963	10.00647	10.76610	8
53	9.23463	9.99351	9.24112	10.75888	10.00649	10.76537	7
54	9.23535	9.99348	9.24187	10.75814	10.00652	10.76465	6
55	9.23607	9.99346	9.24261	10.75739	10.00654	10.76393	5
56	9.23680	9.99344	9.24335	10.75665	10.00656	10.76321	4
57	9.23752	9.99342	9.24410	10.75590	10.00658	10.76248	3
58	9.23824	9.99340	9.24484	10.75516	10.00660	10.76176	2
59	9.23895	9.99337	9.24558	10.75442	10.00663	10.76105	1
60	9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	0
		Sine.		Tang.		Secant.	Min.

80 Degrees.

A Table of Artificial Sines,

10 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.23967	9.99335	9.24632	10.75368	10.00665	10.76633	60
1	9.24039	9.99333	9.24706	10.75294	10.00667	10.75961	59
2	9.24110	9.99331	9.24779	10.75221	10.00669	10.75890	58
3	9.24181	9.99328	9.24853	10.75147	10.00672	10.75819	57
4	9.24253	9.99326	9.24926	10.75074	10.00674	10.75747	56
5	9.24324	9.99324	9.25000	10.75000	10.00676	10.75676	55
6	9.24395	9.99322	9.25073	10.74927	10.00678	10.75605	54
7	9.24466	9.99320	9.25146	10.74854	10.00681	10.75534	53
8	9.24536	9.99317	9.25219	10.74781	10.00683	10.75464	52
9	9.24607	9.99315	9.25292	10.74708	10.00685	10.75393	51
10	9.24678	9.99313	9.25365	10.74635	10.00687	10.75322	50
11	9.24748	9.99310	9.25437	10.74563	10.00690	10.75252	49
12	9.24818	9.99308	9.25510	10.74490	10.00692	10.75182	48
13	9.24888	9.99306	9.25582	10.74418	10.00694	10.75112	47
14	9.24958	9.99304	9.25655	10.74345	10.00696	10.75042	46
15	9.25028	9.99301	9.25727	10.74273	10.00699	10.74972	45
16	9.25098	9.99299	9.25799	10.74201	10.00701	10.74902	44
17	9.25168	9.99297	9.25871	10.74129	10.00703	10.74832	43
18	9.25237	9.99294	9.25943	10.74057	10.00706	10.74763	42
19	9.25307	9.99292	9.26015	10.73985	10.00708	10.74693	41
20	9.25376	9.99290	9.26086	10.73914	10.00710	10.74624	40
21	9.25445	9.99288	9.26158	10.73842	10.00713	10.74555	39
22	9.25514	9.99285	9.26229	10.73771	10.00715	10.74486	38
23	9.25583	9.99283	9.26301	10.73700	10.00717	10.74417	37
24	9.25652	9.99281	9.26372	10.73628	10.00719	10.74348	36
25	9.25721	9.99278	9.26443	10.73557	10.00722	10.74279	35
26	9.25790	9.99276	9.26514	10.73486	10.00724	10.74210	34
27	9.25858	9.99274	9.26585	10.73415	10.00726	10.74142	33
28	9.25927	9.99271	9.26656	10.73345	10.00729	10.74073	32
29	9.25995	9.99270	9.26726	10.73274	10.00731	10.74005	31
30	9.26063	9.99267	9.26797	10.73203	10.00733	10.74937	30
		Sine.		Tang.		Secant.	Min.

79 *Degrees.*

Tangents, and Secants.

10 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.26063	9.99267	9.26797	10.73203	10.00733	10.73937	30
31	9.26131	9.99264	9.26867	10.73133	10.00736	10.73869	29
32	9.26199	9.99262	9.26938	10.73063	10.00738	10.73801	28
33	9.26267	9.99260	9.27008	10.72992	10.00740	10.73733	27
34	9.26335	9.99257	9.27078	10.72922	10.00743	10.73665	26
35	9.26403	9.99255	9.27148	10.72852	10.00745	10.73597	25
36	9.26470	9.99253	9.27218	10.72782	10.00748	10.73530	24
37	9.26538	9.99250	9.27288	10.72712	10.00750	10.73462	23
38	9.26605	9.99248	9.27357	10.72643	10.00752	10.73395	22
39	9.26672	9.99245	9.27427	10.72573	10.00755	10.73328	21
40	9.26739	9.99243	9.27496	10.72504	10.00757	10.73261	20
41	9.26807	9.99241	9.27566	10.72434	10.00759	10.73193	19
42	9.26873	9.99238	9.27635	10.72365	10.00762	10.73127	18
43	9.26940	9.99236	9.27704	10.72296	10.00764	10.73060	17
44	9.27007	9.99234	9.27773	10.72227	10.00767	10.72993	16
45	9.27074	9.99231	9.27842	10.72158	10.00769	10.72927	15
46	9.27140	9.99229	9.27911	10.72089	10.00771	10.72860	14
47	9.27206	9.99226	9.27980	10.72020	10.00774	10.72794	13
48	9.27273	9.99224	9.28049	10.71951	10.00776	10.72727	12
49	9.27339	9.99221	9.28117	10.71883	10.00779	10.72661	11
50	9.27405	9.99219	9.28186	10.71814	10.00781	10.72595	10
51	9.27471	9.99217	9.28254	10.71746	10.00783	10.72529	9
52	9.27587	9.99214	9.28323	10.71678	10.00786	10.72463	8
53	9.27602	9.99212	9.28391	10.71609	10.00788	10.72398	7
54	9.27668	9.99209	9.28459	10.71541	10.00791	10.72661	6
55	9.27734	9.99207	9.28527	10.71473	10.00793	10.72266	5
56	9.27799	9.99204	9.28595	10.71405	10.00796	10.72201	4
57	9.27864	9.99202	9.28662	10.71338	10.00798	10.72136	3
58	9.27930	9.99200	9.28730	10.71270	10.00800	10.72070	2
59	9.27995	9.99197	9.28798	10.71202	10.00803	10.72005	1
60	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	0
		Sine.		Tang.		Secant.	Min.

79 *Degrees.*

A Table of Artificial Sines,

11 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
1	9.28125	9.99192	9.28933	10.71067	10.00808	10.71875	59
2	9.28190	9.99190	9.29000	10.71000	10.00810	10.71810	58
3	9.28254	9.99187	9.29067	10.70933	10.00813	10.71746	57
4	9.28319	9.99185	9.29134	10.70866	10.00815	10.71681	56
5	9.28384	9.99182	9.29201	10.70799	10.00818	10.71616	55
6	9.28448	9.99180	9.29268	10.70732	10.00820	10.71552	54
7	9.28512	9.99177	9.29335	10.70665	10.00823	10.71488	53
8	9.28577	9.99175	9.29402	10.70598	10.00825	10.71423	52
9	9.28641	9.99172	9.29468	10.70532	10.00828	10.71359	51
10	9.28705	9.99170	9.29535	10.70465	10.00830	10.71295	50
11	9.28769	9.99167	9.29601	10.70399	10.00833	10.71231	49
12	9.28833	9.99165	9.29668	10.70332	10.00835	10.71167	48
13	9.28896	9.99162	9.29734	10.70266	10.00838	10.71104	47
14	9.28960	9.99160	9.29800	10.70200	10.00840	10.71040	46
15	9.29024	9.99157	9.29866	10.70134	10.00843	10.70976	45
16	9.29087	9.99155	9.29932	10.70068	10.00845	10.70913	44
17	9.29150	9.99152	9.29998	10.70002	10.00848	10.70850	43
18	9.29214	9.99150	9.30064	10.69936	10.00850	10.70786	42
19	9.29277	9.99147	9.30130	10.69871	10.00853	10.70723	41
20	9.29340	9.99145	9.30195	10.69805	10.00855	10.70660	40
21	9.29403	9.99142	9.30261	10.69739	10.00858	10.70597	39
22	9.29466	9.99140	9.30326	10.69674	10.00860	10.70534	38
23	9.29529	9.99137	9.30391	10.69609	10.00863	10.70471	37
24	9.29591	9.99135	9.30457	10.69543	10.00865	10.70409	36
25	9.29654	9.99132	9.30522	10.69478	10.00868	10.70346	35
26	9.29716	9.99130	9.30587	10.69413	10.00871	10.70284	34
27	9.29779	9.99127	9.30652	10.69438	10.00873	10.70221	33
28	9.29841	9.99124	9.30717	10.69283	10.00876	10.70159	32
29	9.29903	9.99122	9.30782	10.69218	10.00878	10.70097	31
30	9.29966	9.99119	9.30846	10.69154	10.00881	10.70035	30
		Sine.		Tang.		Secant.	Min.

78 Degrees.

Tangents, and Secants.

11 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.29966	9.99119	9.30846	10.69154	10.00881	10.70035	30
31	9.30028	9.99117	9.30911	10.69089	10.00883	10.69972	29
32	9.30090	9.99114	9.30975	10.69025	10.00886	10.69911	28
33	9.30151	9.99112	9.31040	10.68960	10.00889	10.69849	27
34	9.30213	9.99109	9.31104	10.68896	10.00891	10.69787	26
35	9.30275	9.99106	9.31169	10.68832	10.00894	10.69725	25
36	9.30336	9.99104	9.31233	10.68767	10.00896	10.69664	24
37	9.30398	9.99101	9.31297	10.68703	10.00899	10.69602	23
38	9.30459	9.99099	9.31361	10.68639	10.00901	10.69541	22
39	9.30521	9.99096	9.31425	10.68575	10.00904	10.69479	21
40	9.30582	9.99093	9.31489	10.68512	10.00907	10.69418	20
41	9.30643	9.99091	9.31552	10.68448	10.00909	10.69357	19
42	9.30704	9.99088	9.31616	10.68384	10.00912	10.69296	18
43	9.30765	9.99086	9.31680	10.68321	10.00915	0.69235	17
44	9.30826	9.99083	9.31743	10.68257	10.00917	10.69174	16
45	9.30887	9.99080	9.31806	10.68194	10.00920	10.69113	15
46	9.30947	9.99078	9.31870	10.68130	10.00922	10.69053	14
47	9.31008	9.99075	9.31933	10.68067	10.00925	10.68992	13
48	9.31069	9.99072	9.31996	10.68004	10.00928	10.68932	12
49	9.31129	9.99070	9.32059	10.67941	10.00930	10.68871	11
50	9.31189	9.99067	9.32122	10.67878	10.00933	10.68811	10
51	9.31250	9.99064	9.32185	10.67815	10.00936	10.68751	9
52	9.31310	9.99062	9.32248	10.67752	10.00938	10.68690	8
53	9.31370	9.99059	9.32311	10.67689	10.00941	10.68630	7
54	9.31430	9.99057	9.32373	10.67627	10.00944	10.68570	6
55	9.31490	9.99054	9.32436	10.67564	10.00946	10.68510	5
56	9.31550	9.99051	9.32498	10.67502	10.00949	10.68451	4
57	9.31609	9.99049	9.32561	10.67439	10.00952	10.68391	3
58	9.31669	9.99046	9.32623	10.67377	0.00954	10.68331	2
59	9.31728	9.99043	9.32685	10.67315	10.00957	0.68272	1
60	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	0
		Sine.		Tang.		Secant.	Min.

78 *Degrees.*

A Table of Artificial Sines,

12 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	60
1	9.31847	9.99038	9.32810	10.67191	10.00962	10.68153	59
2	9.31907	9.99035	9.32872	10.67129	10.00965	10.68093	58
3	9.31966	9.99032	9.32933	10.67067	10.00968	10.68034	57
4	9.32025	9.99030	9.32995	10.67005	10.00970	10.67975	56
5	9.32084	9.99027	9.33057	10.66943	10.00973	10.67916	55
6	9.32143	9.99024	9.33119	10.66881	10.00976	10.67857	54
7	9.32202	9.99022	9.33180	10.66820	10.00978	10.67798	53
8	9.32261	9.99019	9.33242	10.66758	10.00981	10.67739	52
9	9.32319	9.99016	9.33303	10.66697	10.00984	10.67681	51
10	9.32378	9.99013	9.33365	10.66635	10.00987	10.67622	50
11	9.32437	9.99011	9.33426	10.66574	10.00989	10.67563	49
12	9.32495	9.99008	9.33487	10.66513	10.00992	10.67505	48
13	9.32553	9.99005	9.33548	10.66452	10.00995	10.67447	47
14	9.32612	9.99003	9.33609	10.66391	10.00998	10.67388	46
15	9.32670	9.99000	9.33670	10.66330	10.01000	10.67330	45
16	9.32728	9.98997	9.33731	10.66269	10.01003	10.67272	44
17	9.32786	9.98994	9.33792	10.66208	10.01006	10.67214	43
18	9.32844	9.98992	9.33853	10.66147	10.01009	10.67156	42
19	9.32902	9.98989	9.33913	10.66087	10.01011	10.67098	41
20	9.32960	9.98986	9.33974	10.66026	10.01014	10.67040	40
21	9.33018	9.98983	9.34034	10.65966	10.01017	10.66982	39
22	9.33075	9.98980	9.34095	10.65905	10.01020	10.66925	38
23	9.33133	9.98978	9.34155	10.65845	10.01022	10.66867	37
24	9.33190	9.98975	9.34216	10.65785	10.01025	10.66810	36
25	9.33248	9.98972	9.34276	10.65724	10.01028	10.66752	35
26	9.33305	9.98969	9.34336	10.65664	10.01031	10.66695	34
27	9.33362	9.98967	9.34396	10.65604	10.01034	10.66638	33
28	9.33420	9.98964	9.34456	10.65544	10.01036	10.66580	32
29	9.33477	9.98961	9.34516	10.65484	10.01039	10.66523	31
30	9.33534	9.98958	9.34576	10.65425	10.01042	10.66466	30
		Sine.		Tang.		Secant.	Min.

77 Degrees.

Tangents, and Secants.

12 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.33534	9.98958	9.34576	10.65425	10.01042	10.66466	30
31	9.33591	9.98955	9.34635	10.65365	10.01045	10.66409	29
32	9.33648	9.98953	9.34695	10.65305	10.01048	10.66353	28
33	9.33704	9.98950	9.34755	10.65246	10.01050	10.66296	27
34	9.33761	9.98947	9.34814	10.65186	10.01053	16.66239	26
35	9.33818	9.98944	9.34874	10.65127	10.01056	10.66183	25
36	9.33874	9.98941	9.34933	10.65067	10.01059	10.66126	24
37	9.33931	9.98938	9.34992	10.65008	10.01062	10.66069	23
38	9.33987	9.98936	9.35051	10.64949	10.01064	10.66013	22
39	9.34043	9.98933	9.35111	10.64889	10.01067	10.65957	21
40	9.34100	9.98930	9.35170	10.64830	10.01070	10.65900	20
41	9.34156	9.98927	9.35229	10.64771	10.01073	10.65844	19
42	9.34212	9.98924	9.35288	10.64712	10.01076	10.65788	18
43	9.34268	9.98921	9.35347	10.64654	10.01079	10.65732	17
44	9.34324	9.98919	9.35405	10.64595	10.01081	10.65676	16
45	9.34380	9.98916	9.35464	10.64536	10.01084	10.65620	15
46	9.34436	9.98913	9.35523	10.64478	10.01087	10.65565	14
47	9.34491	9.98910	9.35581	10.64419	10.01090	10.65509	13
48	9.34547	9.98907	9.35640	10.64360	10.01093	10.65453	12
49	9.34602	9.98904	9.35698	10.64302	10.01096	10.65398	11
50	9.34658	9.98901	9.35757	10.64243	10.01099	10.65342	10
51	9.34713	9.98899	9.35815	10.64185	10.01102	10.65287	9
52	9.34769	9.98896	9.35873	10.64127	10.01104	10.65231	8
53	9.34824	9.98893	9.35931	10.64069	10.01107	10.65176	7
54	9.34879	9.98890	9.35989	10.64011	10.01110	10.65121	6
55	9.34934	9.98887	9.36047	10.63953	10.01113	10.65066	5
56	9.34989	9.98884	9.36105	10.63895	10.01116	10.65011	4
57	9.35044	9.98881	9.36163	10.63837	10.01119	10.64956	3
58	9.35099	9.98878	9.36221	10.63779	10.01122	10.64901	2
59	9.35154	9.98875	9.36279	10.63721	10.01125	10.64846	1
60	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	0
		Sine.		Tang.		Secant.	Min.

77 *Degrees.*

A Table of Artificial Sines,

13 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
1	9.35264	9.98869	9.36394	10.63606	10.01131	10.64737	59
2	9.35318	9.98867	9.36452	10.63548	10.01133	10.64682	58
3	9.35373	9.98864	9.36509	10.63491	10.01136	10.64627	57
4	9.35427	9.98861	9.36566	10.63434	10.01139	10.64573	56
5	9.35482	9.98858	9.36624	10.63376	10.01142	10.64518	55
6	9.35536	9.98855	9.36681	10.63319	10.01145	10.64464	54
7	9.35590	9.98852	9.36738	10.63262	10.01148	10.64410	53
8	9.35644	9.98849	9.36795	10.63205	10.01151	10.64356	52
9	9.35698	9.98846	9.36852	10.63148	10.01154	10.64302	51
10	9.35752	9.98843	9.36909	10.63091	10.01157	10.64248	50
11	9.35806	9.98840	9.36966	10.63034	10.01160	10.64194	49
12	9.35860	9.98837	9.37023	10.62977	10.01163	10.64140	48
13	9.35914	9.98834	9.37080	10.62920	10.01166	10.64086	47
14	9.35968	9.98831	9.37137	10.62863	10.01169	10.64032	46
15	9.36022	9.98828	9.37193	10.62807	10.01172	10.63979	45
16	9.36075	9.98825	9.37250	10.62750	10.01175	10.63925	44
17	9.36129	9.98822	9.37306	10.62694	10.01178	10.63871	43
18	9.36182	9.98819	9.37363	10.62637	10.01181	10.63818	42
19	9.36236	9.98816	9.37419	10.62581	10.01184	10.63764	41
20	9.36289	9.98813	9.37476	10.62524	10.01187	10.63711	40
21	9.36342	9.98810	9.37532	10.62468	10.01190	10.63658	39
22	9.36395	9.98807	9.37588	10.62412	10.01193	10.63605	38
23	9.36449	9.98804	9.37644	10.62356	10.01196	10.63552	37
24	9.36502	9.98801	9.37700	10.62300	10.01199	10.63498	36
25	9.36555	9.98798	9.37756	10.62244	10.01202	10.63445	35
26	9.36608	9.98795	9.37812	10.62188	10.01205	10.63393	34
27	9.36660	9.98792	9.37868	10.62132	10.01208	10.63340	33
28	9.36713	9.98789	9.37924	10.62076	10.01211	10.63287	32
29	9.36766	9.98786	9.37980	10.62020	10.01214	10.63234	31
30	9.36819	9.98783	9.37035	10.61965	10.01217	10.63182	30
		Sine.		Tang.		Secant.	Min.

76 *Degrees.*

Tangents, and Secants.

13 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.36819	9.98783	9.38035	10.61965	10.01217	10.63182	30
31	9.36871	9.98780	9.38091	10.61909	10.01220	10.63129	29
32	9.36924	9.98777	9.38147	10.61853	10.01223	10.63076	28
33	9.36976	9.98774	9.38202	10.61798	10.01226	10.63024	27
34	9.37029	9.98771	9.38258	10.61743	10.01229	16.62972	26
35	9.37081	9.98768	9.38313	10.61687	10.01232	10.62919	25
36	9.37133	9.98765	9.38368	10.61632	10.01235	10.62867	24
37	9.37185	9.98762	9.38423	10.61577	10.01238	10.62815	23
38	9.37237	9.98759	9.38479	10.61521	10.01241	10.62763	22
39	9.37289	9.98756	9.38534	10.61466	10.01244	10.62711	21
40	9.37341	9.98753	9.38589	10.61411	10.01247	10.62659	20
41	9.37393	9.98750	9.38644	10.61356	10.01250	10.62607	19
42	9.37445	9.98747	9.38699	10.61301	10.01254	10.62555	18
43	9.37497	9.98743	9.38754	10.61246	10.01257	10.62503	17
44	9.37549	9.98740	9.38808	10.61192	10.01260	10.62451	16
45	9.37600	9.98737	9.38863	10.61137	10.01263	10.62400	15
46	9.37652	9.98734	9.38918	10.61082	10.01266	10.62348	14
47	9.37704	9.98731	9.38972	10.61028	10.01269	10.62297	13
48	9.37755	9.98728	9.39027	10.60973	10.01272	10.62245	12
49	9.37806	9.98725	9.39082	10.60919	10.01275	10.62194	11
50	9.37858	9.98722	9.39136	10.60864	10.01278	10.62142	10
51	9.37909	9.98719	9.39190	10.60810	10.01281	10.62091	9
52	9.37960	9.98716	9.39245	10.60755	10.01285	10.62040	8
53	9.38011	9.98712	9.39299	10.60701	10.01288	10.61989	7
54	9.38062	9.98709	9.39353	10.60647	10.01291	10.61938	6
55	9.38113	9.98706	9.39407	10.60593	10.01294	10.61887	5
56	9.38164	9.98703	9.39461	10.60539	10.01297	10.61836	4
57	9.38215	9.98700	9.39515	10.60485	10.01300	10.61785	3
58	9.38266	9.98697	9.39569	10.60431	10.01303	10.61734	2
59	9.38317	9.98694	9.39623	10.60377	10.01306	10.61683	1
60	9.38368	9.98690	9.39677	10.60323	10.01310	10.61633	0
		Sine.		Tang.		Secant.	Min.

76 *Degrees.*

A Table of Artificial Sines,

14 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.38368	9.98690	9.39677	10.60323	10.01310	10.61633	60
1	9.38418	9.98687	9.39731	10.60269	10.01313	10.61582	59
2	9.38469	9.98684	9.39785	10.60215	10.01316	10.61531	58
3	9.38519	9.98681	9.39838	10.60162	10.01319	10.61481	57
4	9.38570	9.98678	9.39892	10.60108	10.01322	10.61430	56
5	9.38620	9.98675	9.39946	10.60055	10.01325	10.61380	55
6	9.38670	9.98671	9.39999	10.60001	10.01329	10.61330	54
7	9.38721	9.98668	9.40052	10.59948	10.01332	10.61279	53
8	9.38771	9.98665	9.40106	10.59894	10.01335	10.61229	52
9	9.38821	9.98662	9.40159	10.59841	10.01338	10.61179	51
10	9.38871	9.98659	9.40212	10.59788	10.01341	10.61129	50
11	9.38921	9.98656	9.40266	10.59734	10.01345	10.61079	49
12	9.38971	9.98652	9.40319	10.59681	10.01348	10.61029	48
13	9.39021	9.98649	9.40372	10.59628	10.01351	10.60979	47
14	9.39071	9.98646	9.40425	10.59575	10.01354	10.60929	46
15	9.39121	9.98643	9.40478	10.59522	10.01357	10.60879	45
16	9.39170	9.98640	9.40531	10.59469	10.01361	10.60830	44
17	9.39220	9.98636	9.40584	10.59416	10.01364	10.60780	43
18	9.39270	9.98633	9.40636	10.59364	10.01367	10.60731	42
19	9.39319	9.98630	9.40689	10.59311	10.01370	10.60681	41
20	9.39369	9.98627	9.40742	10.59258	10.01373	10.60631	40
21	9.39418	9.98623	9.40795	10.59206	10.01377	10.60582	39
22	9.39467	9.98620	9.40847	10.59153	10.01380	10.60533	38
23	9.39517	9.98617	9.40900	10.59100	10.01383	10.60483	37
24	9.39566	9.98614	9.40952	10.59048	10.01386	10.60434	36
25	9.39615	9.98610	9.41005	10.58996	10.01390	10.60385	35
26	9.39664	9.98607	9.41057	10.58943	10.01393	10.60336	34
27	9.39713	9.98604	9.41109	10.58891	10.01396	10.60287	33
28	9.39762	9.98601	9.41162	10.58839	10.01399	10.60238	32
29	9.39811	9.98597	9.41214	10.58786	10.01403	10.60189	31
30	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140	30
		Sine.		Tang.		Secant.	Min.

75 *Degrees.*

Tangents, and Secants.

14 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.39860	9.98594	9.41266	10.58734	10.01406	10.60140	30
31	9.39909	9.98591	9.41318	10.58682	10.01409	10.60091	29
32	9.39958	9.98588	9.41370	10.58630	10.01412	10.60042	28
33	9.40006	9.98584	9.41422	10.58578	10.01416	10.59994	27
34	9.40055	9.98581	9.41474	10.58526	10.01419	10.59945	26
35	9.40104	9.98578	9.41526	10.58474	10.01422	10.59896	25
36	9.40152	9.98575	9.41578	10.58423	10.01426	10.59848	24
37	9.40201	9.98571	9.41629	10.58371	10.01429	10.59800	23
38	9.40249	9.98568	9.41681	10.58319	10.01432	10.59751	22
39	9.40297	9.98565	9.41733	10.58267	10.01435	10.59703	21
40	9.40346	9.98561	9.41784	10.58216	10.01439	10.59655	20
41	9.40394	9.98558	9.41836	10.58164	10.01442	10.59606	19
42	9.40442	9.98555	9.41887	10.58113	10.01445	10.59558	18
43	9.40490	9.98551	9.41939	10.58061	10.01449	10.59510	17
44	9.40538	9.98548	9.41990	10.58010	10.01452	10.59462	16
45	9.40586	9.98545	9.42042	10.57959	10.01455	10.59414	15
46	9.40634	9.98541	9.42093	10.57907	10.01459	10.59366	14
47	9.40682	9.98538	9.42144	10.57856	10.01462	10.59318	13
48	9.40730	9.98535	9.42195	10.57805	10.01465	10.59270	12
49	9.40778	9.98531	9.42246	10.57754	10.01469	10.59222	11
50	9.40825	9.98528	9.42397	10.57703	10.01472	10.59175	10
51	9.40873	9.98525	9.42348	10.57652	10.01475	10.59127	9
52	9.40921	9.98521	9.42399	10.57601	10.01479	10.59079	8
53	9.40968	9.98518	9.42450	10.57550	10.01482	10.59032	7
54	9.41016	9.98515	9.42501	10.57499	10.01485	10.58984	6
55	9.41063	9.98511	9.42552	10.57448	10.01489	10.58937	5
56	9.41111	9.98508	9.42603	10.57397	10.01492	10.58889	4
57	9.41158	9.98505	9.42653	10.57347	10.01495	10.58842	3
58	9.41205	9.98501	9.42704	10.57296	10.01499	10.58795	2
59	9.41252	9.98498	9.42755	10.57245	10.01502	10.58748	1
60	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	0
		Sine.		Tang.		Secant.	Min.

75 Degrees.

A Table of Artificial Sines,

15 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
1	9.41347	9.98491	9.42856	10.57144	10.01509	10.58653	59
2	9.41394	9.98488	9.42906	10.57094	10.01512	10.58606	58
3	9.41441	9.98484	9.42957	10.57043	10.01516	10.58559	57
4	9.41488	9.98481	9.43007	10.56993	10.01519	10.58512	56
5	9.41535	9.98477	9.43057	10.56943	10.01523	10.58465	55
6	9.41582	9.98474	9.43108	10.56893	10.01526	10.58419	54
7	9.41628	9.98471	9.43158	10.56842	10.01529	10.58372	53
8	9.41675	9.98467	9.43208	10.56792	10.01533	10.58325	52
9	9.41722	9.98464	9.43258	10.56742	10.01536	10.58278	51
10	9.41768	9.98460	9.43308	10.56692	10.01540	10.58232	50
11	9.41815	9.98457	9.43358	10.56642	10.01543	10.58185	49
12	9.41862	9.98454	9.43408	10.56592	10.01547	10.58139	48
13	9.41908	9.98450	9.43458	10.56542	10.01550	10.58092	47
14	9.41954	9.98447	9.43508	10.56492	10.01553	10.58046	46
15	9.42001	9.98443	9.43558	10.56442	10.01557	10.57999	45
16	9.42047	9.98440	9.43607	10.56393	10.01560	10.57953	44
17	9.42093	9.98436	9.43657	10.56343	10.01564	10.57907	43
18	9.42140	9.98433	9.43707	10.56293	10.01567	10.57861	42
19	9.42186	9.98429	9.43756	10.56244	10.01571	10.57814	41
20	9.42232	9.98426	9.43806	10.56194	10.01574	10.57768	40
21	9.42278	9.98422	9.43855	10.56145	10.01578	10.57722	39
22	9.42324	9.98419	9.43905	10.56095	10.01581	10.57676	38
23	9.42370	9.98416	9.43954	10.56046	10.01585	10.57630	37
24	9.42416	9.98412	9.43004	10.55996	10.01588	10.57584	36
25	9.42462	9.98409	9.44053	10.55947	10.01592	10.57539	35
26	9.42507	9.98405	9.44102	10.55898	10.01595	10.57493	34
27	9.42553	9.98402	9.44151	10.55849	10.01599	10.57447	33
28	9.42599	9.98398	9.44201	10.55799	10.01602	10.57401	32
29	9.42644	9.98395	9.44250	10.55750	10.01606	10.57356	31
30	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
		Sine.		Tang.		Secant.	Min.

74 *Degrees.*

Tangents, and Secants.

15 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.42690	9.98391	9.44299	10.55701	10.01609	10.57310	30
31	9.42735	9.98388	9.44348	10.55652	10.01612	10.57265	29
32	9.42781	9.98384	9.44397	10.55603	10.01616	10.57219	28
33	9.42826	9.98381	9.44446	10.55554	10.01620	10.57174	27
34	9.42872	9.98377	9.44495	10.55505	10.01623	10.57128	26
35	9.42917	9.98374	9.44544	10.55457	10.01627	10.57083	25
36	9.42962	9.98370	9.44592	10.55408	10.01630	10.57038	24
37	9.43008	9.98366	9.44641	10.55359	10.01634	10.56993	23
38	9.43053	9.98363	9.44690	10.55310	10.01637	10.56947	22
39	9.43098	9.98359	9.44738	10.55262	10.01641	10.56902	21
40	9.43143	9.98356	9.44787	10.55213	10.01644	10.56857	20
41	9.43188	9.98352	9.44836	10.55164	10.01648	10.56812	19
42	9.43233	9.98346	9.44884	10.55116	10.01651	10.56767	18
43	9.43278	9.98345	9.44933	10.55067	10.01655	10.56722	17
44	9.43323	9.98342	9.44981	10.55019	10.01658	10.56677	16
45	9.43367	9.98338	9.45029	10.54971	10.01662	10.56633	15
46	9.43412	9.98335	9.45078	10.54922	10.01666	10.56588	14
47	9.43457	9.98331	9.45126	10.54874	10.01669	10.56543	13
43	9.43502	9.98327	9.45174	10.54826	10.01672	10.56498	12
49	9.43546	9.98324	9.45223	10.54778	10.01676	10.56454	11
50	9.43591	9.98320	9.45271	10.54729	10.01680	10.56409	10
51	9.43635	9.98317	9.45319	10.54681	10.01683	10.56365	9
52	9.43680	9.98313	9.45367	10.54633	10.01687	10.56320	8
53	9.43724	9.98309	9.45415	10.54585	10.01691	10.56276	7
54	9.43769	9.98306	9.45463	10.54537	10.01694	10.56231	6
55	9.43813	9.98302	9.45511	10.54489	10.01698	10.56187	5
56	9.43857	9.98299	9.45559	10.54441	10.01701	10.56143	4
57	9.43901	9.98295	9.45606	10.54394	10.01705	10.56099	3
53	9.43946	9.98291	9.45654	10.54346	10.01709	10.56054	2
59	9.43990	9.98288	9.45702	10.54298	10.01712	10.56010	1
60	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	0
		Sine.		Tang.		Secant.	Min.

74 *Degrees.*

A Table of Artificial Sines,

16 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
1	9.44078	9.98281	9.45797	10.54203	10.01720	10.55922	59
2	9.44122	9.98277	9.45845	10.54155	10.01723	10.55878	58
3	9.44166	9.98273	9.45893	10.54108	10.01727	10.55834	57
4	9.44210	9.98270	9.45940	10.54060	10.01730	10.55790	56
5	9.44254	9.98266	9.45988	10.54013	10.01734	10.55747	55
6	9.44297	9.98262	9.46035	10.53965	10.01738	10.55703	54
7	9.44341	9.98259	9.46082	10.53918	10.01741	10.55659	53
8	9.44385	9.98255	9.46130	10.53870	10.01745	10.55615	52
9	9.44428	9.98251	9.46177	10.53823	10.01749	10.55572	51
10	9.44472	9.98248	9.46224	10.53776	10.01752	10.55528	50
11	9.44516	9.98244	9.46271	10.53729	10.01756	10.55485	49
12	9.44559	9.98240	9.46319	10.53681	10.01760	10.55441	48
13	9.44603	9.98237	9.46366	10.53634	10.01763	10.55397	47
14	9.44646	9.98233	9.46413	10.53587	10.01767	10.55354	46
15	9.44689	9.98229	9.46460	10.53540	10.01771	10.55311	45
16	9.44733	9.98226	9.46507	10.53493	10.01774	10.55267	44
17	9.44776	9.98222	9.46554	10.53446	10.01778	10.55224	43
18	9.44819	9.98218	9.46601	10.53399	10.01782	10.55181	42
19	9.44862	9.98215	9.46648	10.53352	10.01785	10.55138	41
20	9.44905	9.98211	9.46695	10.53306	10.01789	10.55095	40
21	9.44949	9.98207	9.46741	10.53259	10.01793	10.55052	39
22	9.44992	9.98204	9.46788	10.53212	10.01797	10.55909	38
23	9.45035	9.98200	9.46835	10.53165	10.01800	10.54965	37
24	9.45078	9.98196	9.46881	10.53119	10.01804	10.54923	36
25	9.45120	9.98192	9.46928	10.53072	10.01808	10.54880	35
26	9.45163	9.98189	9.46975	10.53025	10.01811	10.54837	34
27	9.45206	9.98185	9.47021	10.52979	10.01815	10.54794	33
28	9.45249	9.98181	9.47068	10.52932	10.01819	10.54751	32
29	9.45292	9.98177	9.47114	10.52886	10.01823	10.54709	31
30	9.45334	9.98174	9.47161	10.52840	10.01826	10.54666	30
		Sine.		Tang.		Secant.	Min.

73 *Degrees.*

Tangents, and Secants.

16 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.45334	9.98174	9.47161	10.52840	10.01826	10.54666	30
31	9.45377	9.98170	9.47207	10.52793	10.01830	10.54623	29
32	9.45419	9.98166	9.47253	10.52747	10.01834	10.54581	28
33	9.45462	9.98162	9.47300	10.52701	10.01838	10.54538	27
34	9.45504	9.98159	9.47346	10.52654	10.01841	10.54496	26
35	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25
36	9.45589	9.98151	9.47438	10.52562	10.01849	10.54411	24
37	9.45632	9.98147	9.47484	10.52516	10.01853	10.54368	23
38	9.45674	9.98144	9.47530	10.52470	10.01856	10.54326	22
39	9.45716	9.98140	9.47576	10.52424	10.01860	10.54284	21
40	9.45758	9.98136	9.47622	10.52378	10.01864	10.54242	20
41	9.45801	9.98132	9.47668	10.52332	10.01868	10.54199	19
42	9.45843	9.98129	9.47714	10.52286	10.01872	10.54157	18
43	9.45885	9.98125	9.47760	10.52240	10.01875	10.54115	17
44	9.45927	9.98121	9.47806	10.52194	10.01879	10.54073	16
45	9.45969	9.98117	9.47852	10.52148	10.01883	10.54031	15
46	9.46011	9.98113	9.47898	10.52103	10.01887	10.53989	14
47	9.46053	9.98110	9.47943	10.52057	10.01891	10.53947	13
48	9.46095	9.98106	9.47989	10.52011	10.01894	10.53905	12
49	9.46136	9.98102	9.48035	10.51966	10.01898	10.53864	11
50	9.46178	9.98098	9.48080	10.51920	10.01902	10.53822	10
51	9.46220	9.98094	9.48126	10.51874	10.01906	10.53780	9
52	9.46262	9.98090	9.48171	10.51829	10.01910	10.53738	8
53	9.46303	9.98087	9.48217	10.51783	10.01913	10.53697	7
54	9.46345	9.98083	9.48262	10.51738	10.01917	10.53655	6
55	9.46386	9.98079	9.48308	10.51693	10.01921	10.53614	5
56	9.46428	9.98075	9.48353	10.51647	10.01925	10.53572	4
57	9.46469	9.98071	9.48398	10.51602	10.01929	10.53531	3
58	9.46511	9.98067	9.48443	10.51557	10.01933	10.53489	2
59	9.46552	9.98064	9.48489	10.51511	10.01937	10.53448	1
60	9.46594	9.98060	9.48534	10.51566	10.01940	10.53406	0
		Sine.		Tang.		Secant.	Min.

73 *Degrees.*

A Table of Artificial Sines,

17 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53406	60
1	9.46635	9.98056	9.48579	10.51421	10.01944	10.53365	59
2	9.46676	9.98052	9.48624	10.51376	10.01948	10.53324	58
3	9.46717	9.98048	9.48669	10.51331	10.01952	10.53283	57
4	9.46759	9.98044	9.48714	10.51286	10.01956	10.53242	56
5	9.46800	9.98040	9.48759	10.51240	10.01960	10.53200	55
6	9.46841	9.98036	9.48804	10.51196	10.01964	10.53159	54
7	9.46882	9.98033	9.48849	10.51151	10.01968	10.53118	53
8	9.46923	9.98029	9.48894	10.51106	10.01971	10.53077	52
9	9.46964	9.98025	9.48939	10.51061	10.01975	10.53036	51
10	9.47005	9.98021	9.48984	10.51016	10.01979	10.52995	50
11	9.47046	9.98017	9.49029	10.50971	10.01983	10.52954	49
12	9.47086	9.98013	9.49073	10.50927	10.01987	10.52914	48
13	9.47127	9.98009	9.49118	10.50882	10.01991	10.52873	47
14	9.47168	9.98005	9.49163	10.50837	10.01995	10.52832	46
15	9.47209	9.98001	9.49207	10.50793	10.01999	10.52791	45
16	9.47249	9.97997	9.49252	10.50748	10.02003	10.52751	44
17	9.47290	9.97993	9.49297	10.50704	10.02007	10.52710	43
18	9.47330	9.97990	9.49341	10.50659	10.02011	10.52670	42
19	9.47371	9.97986	9.49385	10.50615	10.02015	10.52629	41
20	9.47412	9.97982	9.49430	10.50570	10.02018	10.52588	40
21	9.47452	9.97978	9.49475	10.50526	10.02022	10.52548	39
22	9.47492	9.97974	9.49519	10.50481	10.02026	10.52508	38
23	9.47533	9.97970	9.49563	10.50437	10.02030	10.52467	37
24	9.47573	9.97966	9.49607	10.50393	10.02034	10.52427	36
25	9.47613	9.97962	9.49652	10.50349	10.02038	10.52387	35
26	9.47654	9.97958	9.49696	10.50304	10.02042	10.52346	34
27	9.47694	9.97954	9.49740	10.50260	10.02046	10.52306	33
28	9.47734	9.97950	9.49784	10.50216	10.02050	10.52266	32
29	9.47774	9.97946	9.49828	10.50172	10.02054	10.52226	31
30	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
		Sine.		Tang.		Secant.	Min.

72 *Degrees.*

Tangents, and Secants.

17 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.47814	9.97942	9.49872	10.50128	10.02058	10.52186	30
31	9.47854	9.97938	9.49916	10.50084	10.02062	10.52146	29
32	9.47894	9.97934	9.49960	10.50040	10.02066	10.52106	28
33	9.47934	9.97930	9.50004	10.49996	10.02070	10.52066	27
34	9.47974	9.97926	9.50048	10.49952	10.02074	10.52026	26
35	9.48014	9.97922	9.50092	10.49908	10.02078	10.51986	25
36	9.48054	9.97918	9.50136	10.49864	10.02072	10.51946	24
37	9.48094	9.97914	9.50180	10.49820	10.02086	10.51906	23
38	9.48133	9.97910	9.50224	10.49777	10.02090	10.51867	22
39	9.48173	9.97906	9.50267	10.49733	10.02094	10.51827	21
40	9.48213	9.97902	9.50311	10.49689	10.02098	10.51787	20
41	9.48253	9.97898	9.50355	10.49645	10.02102	10.51747	19
42	9.48292	9.97894	9.50398	10.49602	10.02106	10.51708	18
43	9.48332	9.97890	9.50442	10.49558	10.02110	10.51668	17
44	9.48371	9.97886	9.50485	10.49515	10.02114	10.51629	16
45	9.48411	9.97882	9.50529	10.49471	10.02118	10.51589	15
46	9.48450	9.97878	9.50572	10.49428	10.02122	10.51550	14
47	9.48490	9.97874	9.50616	10.49384	10.02126	10.51510	13
48	9.48529	9.97870	9.50659	10.49341	10.02130	10.51471	12
49	9.48568	9.97866	9.50703	10.49297	10.02135	10.51432	11
50	9.48608	9.97862	9.50746	10.49254	10.02139	10.51393	10
51	9.48647	9.97857	9.50789	10.49211	10.02143	10.51353	9
52	9.48686	9.97853	9.50833	10.49167	10.02147	10.51314	8
53	9.48725	9.97849	9.50876	10.49124	10.02151	10.51275	7
54	9.48764	9.97845	9.50919	10.49081	10.02155	10.51236	6
55	9.48803	9.97841	9.50962	10.49038	10.02159	10.51197	5
56	9.48842	9.97837	9.51005	10.48995	10.02163	10.51158	4
57	9.48881	9.97833	9.51049	10.48952	10.02167	10.51119	3
58	9.48920	9.97829	9.51092	10.48908	10.02172	10.51080	2
59	9.48959	9.97825	9.51135	10.48865	10.02175	10.51041	1
60	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	0
		Sine.		Tang.		Secant.	Min.

72 *Degrees.*

A Table of Artificial Sines,

18 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	60
1	9.49037	9.97817	9.51221	10.48779	10.02184	10.50963	59
2	9.49076	9.97812	9.51264	10.48737	10.02188	10.50924	58
3	9.49115	9.97808	9.51306	10.48694	10.02192	10.50885	57
4	9.49153	9.97804	9.51349	10.48651	10.02196	10.50847	56
5	9.49192	9.97800	9.51392	10.48608	10.02200	10.50808	55
6	9.49231	9.97796	9.51435	10.48565	10.02204	10.50769	54
7	9.49270	9.97792	9.51478	10.48522	10.02208	10.50730	53
8	9.49308	9.97788	9.51520	10.48480	10.02212	10.50692	52
9	9.49347	9.97784	9.51563	10.48437	10.02217	10.50653	51
10	9.49385	9.97779	9.51606	10.48394	10.02221	10.50615	50
11	9.49424	9.97775	9.51648	10.48352	10.02225	10.50576	49
12	9.49462	9.97771	9.51691	10.48309	10.02229	10.50538	48
13	9.49501	9.97767	9.51734	10.48267	10.02233	10.50500	47
14	9.49539	9.97763	9.51776	10.48224	10.02237	10.50461	46
15	9.49577	9.97759	9.51819	10.48181	10.02241	10.50423	45
16	9.49615	9.97754	9.51861	10.48139	10.02246	10.50385	44
17	9.49654	9.97750	9.51903	10.48097	10.02250	10.50346	43
18	9.49692	9.97746	9.51946	10.48054	10.02254	10.50308	42
19	9.49730	9.97742	9.51988	10.48012	10.02258	10.50270	41
20	9.49768	9.97738	9.52031	10.47970	10.02262	10.50232	40
21	9.49806	9.97734	9.52073	10.47927	10.02267	10.50194	39
22	9.49844	9.97729	9.52115	10.47885	10.02271	10.50156	38
23	9.49882	9.97725	9.52157	10.47843	10.02275	10.50118	37
24	9.49920	9.97721	9.52200	10.47801	10.02279	10.50080	36
25	9.49958	9.97717	9.52242	10.47758	10.02283	10.50042	35
26	9.49996	9.97713	9.52284	10.47716	10.02288	10.50004	34
27	9.50034	9.97708	9.52326	10.47674	10.02292	10.50966	33
28	9.50072	9.97704	9.52368	10.47632	10.02296	10.50928	32
29	9.50110	9.97700	9.52410	10.47590	10.02300	10.50890	31
30	9.50148	9.97696	9.52452	10.47548	10.02304	10.50852	30
		Sine.		Tang.		Secant.	Min.

71 *Degrees.*

Tangents, and Secants.

18 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.50148	9.97696	9.52452	10.47548	10.02304	10.49852	30
31	9.50185	9.97691	9.52494	10.47506	10.02309	10.49815	29
32	9.50223	9.97687	9.52536	10.47464	10.02313	10.49777	28
33	9.50261	9.97683	9.52578	10.47422	10.02317	10.49739	27
34	9.50298	9.97679	9.52620	10.47380	10.02321	10.49702	26
35	9.50336	9.97675	9.52662	10.47339	10.02326	10.49664	25
36	9.50374	9.97670	9.52703	10.47297	10.02330	10.49627	24
37	9.50411	9.97666	9.52745	10.47255	10.02334	10.49589	23
38	9.50449	9.97662	9.52787	10.47213	10.02338	10.49551	22
39	9.50486	9.97657	9.52829	10.47172	10.02343	10.49514	21
40	9.50523	9.97653	9.52870	10.47130	10.02347	10.49477	20
41	9.50561	9.97649	9.52912	10.47088	10.02351	10.49439	19
42	9.50598	9.97645	9.52954	10.47047	10.02355	10.49402	18
43	9.50635	9.97640	9.52995	10.47005	10.02360	10.49365	17
44	9.50673	9.97636	9.53037	10.46963	10.02364	10.49327	16
45	9.50710	9.97632	9.53078	10.46922	10.02368	10.49290	15
46	9.50747	9.97628	9.53120	10.46880	10.02373	10.49253	14
47	9.50784	9.97623	9.53161	10.46839	10.02377	10.49216	13
48	9.50821	9.97619	9.53203	10.46798	10.02381	10.49179	12
49	9.50859	9.97615	9.53244	10.46756	10.02385	10.49141	11
50	9.50896	9.97610	9.53285	10.46715	10.02390	10.49104	10
51	9.50933	9.97606	9.53327	10.46673	10.02394	10.49067	9
52	9.50970	9.97602	9.53368	10.46632	10.02398	10.49030	8
53	9.51007	9.97597	9.53409	10.46591	10.02403	10.48994	7
54	9.51043	9.97593	9.53450	10.46550	10.02407	10.48957	6
55	9.51080	9.97589	9.53492	10.46508	10.02411	10.48920	5
56	9.51117	9.97584	9.53533	10.46467	10.02416	10.48883	4
57	9.51154	9.97580	9.53574	10.46426	10.02420	10.48846	3
58	9.51191	9.97576	9.53615	10.46385	10.02424	10.48809	2
59	9.51228	9.97571	9.53656	10.46344	10.02429	10.48773	1
60	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	0
		Sine.		Tang.		Secant.	Min.

71 Degrees.

A Table of Artificial Sines,

19 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
1	9.51301	9.97563	9.53738	10.46262	10.02437	10.48699	59
2	9.51338	9.97558	9.53779	10.46221	10.02442	10.48663	58
3	9.51374	9.97554	9.53820	10.46180	10.02446	10.48626	57
4	9.51411	9.97550	9.53861	10.46139	10.02450	10.48589	56
5	9.51447	9.97545	9.53902	10.46098	10.02455	10.48553	55
6	9.51484	9.97541	9.53943	10.46057	10.02459	10.48516	54
7	9.51520	9.97537	9.53984	10.46016	10.02464	10.48480	53
8	9.51557	9.97532	9.54025	10.45976	10.02468	10.48443	52
9	9.51593	9.97528	9.54065	10.45935	10.02472	10.48407	51
10	9.51629	9.97523	9.54106	10.45894	10.02477	10.48371	50
11	9.51666	9.97519	9.54147	10.45853	10.02481	10.48334	49
12	9.51702	9.97515	9.54188	10.45813	10.02486	10.48298	48
13	9.51738	9.97510	9.54228	10.45772	10.02490	10.48262	47
14	9.51775	9.97506	9.54269	10.45731	10.02494	10.48225	46
15	9.51811	9.97501	9.54309	10.45691	10.02499	10.48189	45
16	9.51847	9.97497	9.54350	10.45650	10.02503	10.48153	44
17	9.51883	9.97493	9.54391	10.45610	10.02508	10.48117	43
18	9.51919	9.97488	9.54431	10.45569	10.02512	10.48081	42
19	9.51955	9.97484	9.54472	10.45528	10.02516	10.48045	41
20	9.51991	9.97479	9.54512	10.45488	10.02521	10.48009	40
21	9.52027	9.97475	9.54552	10.45448	10.02525	10.47973	39
22	9.52063	9.97470	9.54593	10.45407	10.02530	10.47937	38
23	9.52099	9.97466	9.54633	10.45367	10.02534	10.47901	37
24	9.52135	9.97461	9.54673	10.45327	10.02539	10.47865	36
25	9.52171	9.97457	9.54714	10.45286	10.02543	10.47829	35
26	9.52207	9.97453	9.54754	10.45246	10.02548	10.47793	34
27	9.52242	9.97448	9.54794	10.45206	10.02552	10.47758	33
28	9.52278	9.97444	9.54835	10.45166	10.02556	10.47722	32
29	9.52314	9.97439	9.54875	10.45125	10.02561	10.47686	31
30	9.52350	9.97435	9.54915	10.45085	10.02565	10.47651	30
		Sine.		Tang.		Secant.	Min.

70 *Degrees.*

Tangents, and Secants.

19 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.52350	9.97435	9.54915	10.45085	10.02565	10.47651	30
31	9.52385	9.97430	9.54955	10.45045	10.02570	10.47615	29
32	9.52421	9.97426	9.54995	10.45005	10.02574	10.47579	28
33	9.52456	9.97421	9.55035	10.44965	10.02579	10.47544	27
34	9.52492	9.97417	9.55075	10.44925	10.02583	10.47508	26
35	9.52528	9.97412	9.55115	10.44885	10.02587	10.47472	25
36	9.52563	9.97408	9.55155	10.44845	10.02592	10.47437	24
37	9.52598	9.97403	9.55195	10.44805	10.02597	10.47402	23
38	9.52634	9.97399	9.55235	10.44765	10.02601	10.47366	22
39	9.52669	9.97394	9.55275	10.44725	10.02606	10.47331	21
40	9.52705	9.97390	9.55315	10.44685	10.02610	10.47295	20
41	9.52740	9.97385	9.55355	10.44645	10.02615	10.47260	19
42	9.52775	9.97381	9.55395	10.44605	10.02619	10.47225	18
43	9.52811	9.97376	9.55434	10.44566	10.02624	10.47190	17
44	9.52846	9.97372	9.55474	10.44526	10.02628	10.47154	16
45	9.52881	9.97367	9.55514	10.44486	10.02633	10.47119	15
46	9.52916	9.97363	9.55554	10.44446	10.02637	10.47084	14
47	9.52951	9.97358	9.55593	10.44407	10.02642	10.47049	13
48	9.52986	9.97354	9.55633	10.44367	10.02647	10.47014	12
49	9.53022	9.97349	9.55673	10.44327	10.02651	10.46978	11
50	9.53057	9.97344	9.55712	10.44288	10.02656	10.46944	10
51	9.53092	9.97340	9.55752	10.44248	10.02660	10.46908	9
52	9.53127	9.97335	9.55791	10.44209	10.02665	10.46874	8
53	9.53161	9.97331	9.55831	10.44169	10.02669	10.46839	7
54	9.53196	9.97326	9.55870	10.44130	10.02674	10.46804	6
55	9.53231	9.97322	9.55910	10.44090	10.02679	10.46769	5
56	9.53266	9.97317	9.55949	10.44051	10.02683	10.46734	4
57	9.53301	9.97312	9.55989	10.44012	10.02688	10.46699	3
58	9.53336	9.97308	9.56028	10.43972	10.02692	10.46664	2
59	9.53370	9.97303	9.56067	10.43933	10.02697	10.46630	1
60	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	0
		Sine.		Tang.		Secant.	Min.

70 *Degrees.*

A Table of Artificial Sines,

20 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	60
1	9.53440	9.97294	9.56146	10.43854	10.02706	10.46560	59
2	9.53475	9.97289	9.56185	10.43815	10.02711	10.46526	58
3	9.53509	9.97285	9.56224	10.43776	10.02715	10.46491	57
4	9.53544	9.97280	9.56264	10.43736	10.02720	10.46456	56
5	9.53578	9.97276	9.56303	10.43697	10.02725	10.46422	55
6	9.53613	9.97271	9.56342	10.43658	10.02729	10.46387	54
7	9.53647	9.97266	9.56381	10.43619	10.02734	10.46353	53
8	9.53682	9.97262	9.56420	10.43580	10.02738	10.46318	52
9	9.53716	9.97257	9.56459	10.43541	10.02743	10.46284	51
10	9.53751	9.97252	9.56498	10.43502	10.02748	10.46249	50
11	9.53785	9.97248	9.56537	10.43463	10.02752	10.46215	49
12	9.53819	9.97243	9.56576	10.43524	10.02757	10.46181	48
13	9.53854	9.97238	9.56615	10.43385	10.02762	10.46146	47
14	9.53888	9.97234	9.56654	10.43346	10.02766	10.46112	46
15	9.53922	9.97229	9.56693	10.43307	10.02771	10.46078	45
16	9.53957	9.97225	9.56732	10.43268	10.02776	10.46044	44
17	9.53991	9.97220	9.56771	10.43229	10.02780	10 46009	43
18	9.54025	9.97215	9.56810	10.43190	10.02785	10.45975	42
19	9.54059	9.97211	9.56849	10.43151	10.02790	10.45941	41
20	9.54093	9.97206	9.56887	10.43113	10.02794	10.45907	40
21	9.54127	9.97201	9.56926	10.43074	10.02799	10.45873	39
22	9.54161	9.97196	9.56965	10.43035	10.02804	10.45839	38
23	9.54195	9.97192	9.57004	10.42996	10.02808	10.45805	37
24	9.54229	9.97187	9.57042	10.42958	10.02813	10.45771	36
25	9.54263	9.97182	9.57081	10.42919	10.02818	10.45737	35
26	9.54297	9.97178	9.57120	10.42880	10.02822	10.45703	34
27	9.54331	9.97173	9.57158	10.42842	10.02827	10.45669	33
28	9.54365	9.97168	9.57197	10.42803	10.02832	10.45635	32
29	9.54399	9.97164	9.57235	10.42765	10.02837	10.45601	31
30	9.54433	9.97159	9.57274	10.42726	10.02841	10.45567	30
		Sine.		Tang.		Secant.	Min.

69 *Degrees.*

Tangents, and Secants.

20 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.54433	9.97159	9.57274	10.42726	10.02841	10.45567	30
31	9.54466	9.97154	9.57312	10.42688	10.02846	10.45534	29
32	9.54500	9.97149	9.57351	10.42649	10.02851	10.45500	28
33	9.54534	9.97145	9.57389	10.42611	10.02855	10.45466	27
34	9.54567	9.97140	9.57428	10.42572	10.02860	10.45433	26
35	9.54601	9.97135	9.57466	10.42534	10.02865	10.45399	25
36	9.54635	9.97130	9.57504	10.42469	10.02870	10.45365	24
37	9.54668	9.97126	9.57543	10.42457	10.02874	10.45332	23
38	9.54702	9.97121	9.57581	10.42419	10.02879	10.45298	22
39	9.54735	9.97116	9.57619	10.42381	10.02884	10.45265	21
40	9.54769	9.97111	9.57658	10.42342	10.02889	10.45231	20
41	9.54802	9.97107	9.57696	10.42304	10.02893	10.45198	19
42	9.54836	9.97102	9.57734	10.42266	10.02898	10.45164	18
43	9.54869	9.97097	9.57772	10.42228	10.02903	10.45131	17
44	9.54903	9.97092	9.57810	10.42190	10.02908	10.45097	16
45	9.54936	9.97087	9.57849	10.42151	10.02913	10.45064	15
46	9.54969	9.97083	9.57887	10.42113	10.02917	10.45031	14
47	9.55003	9.97078	9.57925	10.42075	10.02922	10.44997	13
48	9.55036	9.97073	9.57963	10.42037	10.02927	10.44964	12
49	9.55069	9.97068	9.58001	10.41999	10.02932	10.44931	11
50	9.55102	9.97064	9.58039	10.41961	10.02937	10.44898	10
51	9.55136	9.97059	9.58077	10.41923	10.02941	10.44864	9
52	9.55169	9.97054	9.58115	10.41885	10.02946	10.44831	8
53	9.55202	9.97049	9.58153	10.41847	10.02951	10.44798	7
54	9.55235	9.97044	9.58191	10.41809	10.02956	10.44765	6
55	9.55268	9.97039	9.58229	10.41771	10.02961	10.44732	5
56	9.55301	9.97035	9.58267	10.41734	10.02966	10.44699	4
57	9.55334	9.97030	9.58304	10.41696	10.02970	10.44666	3
58	9.55367	9.97025	9.58342	10.41658	10.02975	10.44633	2
59	9.55400	9.97020	9.58380	10.41620	10.02980	10.44600	1
60	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	0
		Sine.		Tang.		Secant.	Min.

69 *Degrees.*

A Table of Artificial Sines,

21 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
1	9.55466	9.97010	9.58456	10.41545	10.02990	10.44534	59
2	9.55499	9.97006	9.58493	10.41507	10.02995	10.44501	58
3	9.55532	9.97001	9.58531	10.41469	10.02999	10.44468	57
4	9.55564	9.96996	9.58569	10.41431	10.03004	10.44435	56
5	9.55597	9.96991	9.58606	10.41394	10.03009	10.44403	55
6	9.55630	9.96986	9.58644	10.41356	10.03014	10.44370	54
7	9.55663	9.96981	9.58682	10.41319	10.03019	10.44337	53
8	9.55695	9.96976	9.58719	10.41281	10.03024	10.44305	52
9	9.55728	9.96971	9.58757	10.41243	10.03029	10.44272	51
10	9.55761	9.96967	9.58794	10.41206	10.03034	10.44239	50
11	9.55793	9.96962	9.58832	10.41168	10.03038	10.44207	49
12	9.55826	9.96957	9.58869	10.41131	10.03043	10.44174	48
13	9.55858	9.96952	9.58907	10.41093	10.03048	10.44142	47
14	9.55891	9.96647	9.58944	10.41056	10.03053	10.44109	46
15	9.55923	9.96942	9.58981	10.41019	10.03058	10.44077	45
16	9.55956	9.96937	9.59019	10.40981	10.03063	10.44044	44
17	9.55988	9.96932	9.59056	10.40944	10.03068	10.44012	43
18	9.56021	9.96927	9.59094	10.40907	10.03073	10.43979	42
19	9.56053	9.96922	9.59131	10.40869	10.03078	10.43947	41
20	9.56086	9.96917	9.59168	10.40832	10.03083	10.43915	40
21	9.56118	9.96912	9.59205	10.40795	10.03088	10.43882	39
22	9.56150	9.96908	9.59243	10.40757	10.03093	10.43850	38
23	9.56182	9.96903	9.59280	10.40720	10.03098	10.43818	37
24	9.56215	9.96898	9.59317	10.40683	10.03102	10.43785	36
25	9.56247	9.96893	9.59354	10.40646	10.03107	10.43753	35
26	9.56280	9.96888	9.59391	10.40609	10 03112	10.43721	34
27	9.56311	9.96883	9.59429	10.40572	10.03118	10.43689	33
28	9.56343	9.96878	9.59466	10.40534	10.03123	10.43657	32
29	9.56376	9.96873	9.59503	10.40497	10.03127	10.43624	31
30	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
		Sine.		Tang.		Secant.	Min.

68 *Degrees.*

Tangents, and Secants.

21 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.56408	9.96868	9.59540	10.40460	10.03132	10.43592	30
31	9.56440	9.96863	9.59577	10.40423	10.03137	10.43560	29
32	9.56472	9.96858	9.59614	10.40386	10.03142	10.43528	28
33	9.56504	9.96853	9.59651	10.40349	10.03147	10.43496	27
34	9.56536	9.96848	9.59688	10.40312	10.03152	10.43464	26
35	9.56568	9.96843	9.59725	10.40275	10.03157	10.43432	25
36	9.56600	9.96838	9.59762	10.40238	10.03162	10.43400	24
37	9.56631	9.96833	9.59799	10.40202	10.03167	10.43369	23
38	9.56663	9.96828	9.59835	10.40165	10.03172	10.43337	22
39	9.56695	9.96823	9.59872	10.40128	10.03177	10.43305	21
40	9.56727	9.96818	9.59909	10.40091	10.03182	10.43273	20
41	9.56759	9.96813	9.59946	10.40054	10.03187	10.43241	19
42	9.56790	9.96808	9.59983	10.40017	10.03192	10.43210	18
43	9.56822	9.96803	9.60019	10.39981	10.03197	10.43178	17
44	9.56854	9.96798	9.60056	10.39944	10.03202	10.43146	16
45	9.56885	9.96793	9.60093	10.39907	10.03207	10.43114	15
46	9.56917	9.96788	9.60130	10.39870	10.03212	10.43083	14
47	9.56949	9.96783	9.60166	10.39834	10.03217	10.43051	13
48	9.56980	9.96778	9.60203	10.39797	10.03223	10.43020	12
49	9.57012	9.96773	9.60240	10.39761	10.03228	10.42988	11
50	9.57044	9.96767	9.60276	10.39724	10.03233	10.42956	10
51	9.57075	9.96762	9.60313	10.39687	10.03238	10.42925	9
52	9.57107	9.96757	9.60349	10.39651	10.03243	10.42893	8
53	9.57138	9.96752	9.60386	10.39614	10.03248	10.42861	7
54	9.57170	9.96747	9.60422	10.39578	10.03253	10.42831	6
55	9.57201	9.96742	9.60459	10.39541	10.03258	10.42799	5
56	9.57232	9.96737	9.60495	10.39505	10.03263	10.42768	4
57	9.57264	9.96732	9.60532	10.39468	10.03268	10.42736	3
58	9.57295	9.96727	9.60568	10.39432	10.03273	10.42705	2
59	9.57326	9.96722	9.60605	10.39395	10.03278	10.42674	1
60	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	0
		Sine.		Tang.		Secant.	Min.

68 *Degrees.*

A Table of Artificial Sines,

22 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
1	9.57389	9.96712	9.60677	10.39323	10.03289	10.42611	59
2	9.57420	9.96706	9.60714	10.39286	10.03294	10.42580	58
3	9.57451	9.96701	9.60750	10.39250	10.03299	10.42549	57
4	9.57482	9.96696	9.60786	10.39214	10.03304	10.42518	56
5	9.57514	9.96691	9.60823	10.39178	10.03309	10.42487	55
6	9.57545	9.96686	9.60859	10.39141	10.03314	10.42455	54
7	9.57576	9.96681	9.60895	10.39105	10.03319	10.42424	53
8	9.57607	9.96676	9.60931	10.39069	10.03324	10.42393	52
9	9.57638	9.96671	9.60967	10.39033	10.03330	10.42362	51
10	9.57669	9.96665	9.61004	10.38996	10.03335	10.42331	50
11	9.57700	9.96660	9.61040	10.38960	10.03340	10.42300	49
12	9.57731	9.96655	9.61076	10.38924	10.03345	10.42269	48
13	9.57762	9.96650	9.61112	10.38888	10.03350	10.42238	47
14	9.57793	9.96645	9.61148	10.38852	10.03355	10.42207	46
15	9.57824	9.96640	9.61184	10.38816	10.03361	10.42176	45
16	9.57855	9.96634	9.61220	10.38780	10.03366	10.42146	44
17	9.57885	9.96629	9.61256	10.38744	10.03371	10.42115	43
18	9.57916	9.96624	9.61292	10.38708	10.03376	10.42084	42
19	9.57947	9.96619	9.61328	10.38672	10.03381	10.42053	41
20	9.57978	9.96614	9.61364	10.38636	10.03386	10.42022	40
21	9.58008	9.96609	9.61400	10.38600	10.03392	10.41992	39
22	9.58039	9.96603	9.61436	10.38564	10.03397	10.41961	38
23	9.58070	9.96598	9.61472	10.38528	10.03402	10.41930	37
24	9.58101	9.96593	9.61508	10.38492	10.03407	10.41900	36
25	9.58131	9.96588	9.61544	10.38457	10.03412	10.41869	35
26	9.58162	9.96582	9.61579	10.38421	10.03418	10.41838	34
27	9.58192	9.96577	9.61615	10.38385	10.03423	10.41808	33
28	9.58223	9.96572	9.61651	10.38349	10.03428	10.41777	32
29	9.58253	9.96567	9.61687	10.38313	10.03433	10.41747	31
30	9.58284	9.96562	9.61722	10.38278	10.03439	10.41716	30
		Sine.		Tang.		Secant.	Min.

67 Degrees.

Tangents, and Secants.

22 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.58284	9.96561	9.61722	10.38278	10.03439	10.41716	30
31	9.58314	9.96556	9.61758	10.38242	10.03444	10.41686	29
32	9.58345	9.96551	9.61794	10.38206	10.03449	10.41655	28
33	9.58375	9.96546	9.61830	10.38171	10.03454	10.41625	27
34	9.58406	9.96541	9.61865	10.38135	10.03459	10.41594	26
35	9.58436	9.96535	9.61901	10.38099	10.03465	10.41564	25
36	9.58467	9.96530	9.61936	10.38064	10.03470	10.41534	24
37	9.58497	9.96525	9.61972	10.38028	10.03475	10.41503	23
38	9.58527	9.96520	9.62008	10.37992	10.03481	10.41473	22
39	9.58557	9.96514	9.62043	10.37957	10.03486	10.41443	21
40	9.58588	9.96509	9.62079	10.37921	10.03491	10.41412	20
41	9.58618	9.96504	9.62114	10.37886	10.03496	10.41382	19
42	9.58648	9.96498	9.62150	10.37850	10.03502	10.41352	18
43	9.58678	9.96493	9.62185	10.37815	10.03507	10.41322	17
44	9.58709	9.96488	9.62221	10.37779	10.03512	10.41291	16
45	9.58739	9.96483	9.62256	10.37744	10.03517	10.41261	15
46	9.58769	9.96477	9.62292	10.37709	10.03522	10.41231	14
47	9.58799	9.96472	9.62327	10.37673	10.03528	10.41201	13
48	9.58829	9.96467	9.62362	10.37638	10.03533	10.41171	12
49	9.58859	9.66461	9.62398	10.37602	10.03539	10.41141	11
50	9.58889	9.96456	9.62433	10.37567	10.03544	10.41111	10
51	9.58919	9.96451	9.62468	10.37532	10.03549	10.41081	9
52	9.58949	9.96445	9.62504	10.37496	10.03555	10.41051	8
53	9.58979	9.96440	9.62539	10.37461	10.03560	10.41021	7
54	9.59009	9.96435	9.62574	10.37426	10.03566	10.40991	6
55	9.59039	9.96429	9.62609	10.37391	10.03571	10.40961	5
56	9.59069	9.96424	9.62645	10.37356	10.03576	10.40931	4
57	9.59098	9.96419	9.62680	10.37320	10.03582	10.40902	3
58	9.59128	9.96413	9.62715	10.37285	10.03587	10.40872	2
59	9.59158	9.96408	9.62750	10.37250	10.03592	10.40842	1
60	9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	0
		Sine.		Tang.		Secant.	Min.

67 Degrees.

A Table of Artificial Sines,

23 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	60
1	9.59218	9.96397	9.62820	10.37180	10.03603	10.40782	59
2	9.59247	9.96392	9.62855	10.37145	10.03608	10.40753	58
3	9.59277	9.96387	9.62891	10.37110	10.03614	10.40723	57
4	9.59307	9.96381	9.62926	10.37075	10.03619	10.40693	56
5	9.59336	9.96376	9.62961	10.37039	10.03624	10.40664	55
6	9.59366	9.96370	9.62996	10.37004	10.03630	10.40634	54
7	9.59396	9.96365	9.63031	10.36969	10.03635	10.40604	53
8	9.59425	9.96360	9.63066	10.36934	10.03640	10.40575	52
9	9.59455	9.96354	9.63101	10.36900	10.03646	10.40545	51
10	9.59484	9.96349	9.63135	10.36865	10.03651	10.40516	50
11	9.59514	9.96343	9.63170	10.36830	10.03657	10.40486	49
12	9.59543	9.96338	9.63205	10.36795	10.03662	10.40457	48
13	9.59573	9.96333	9.63240	10.36760	10.03668	10.40427	47
14	9.59602	9.96327	9.63275	10.36725	10.03673	10.40398	46
15	9.59632	9.96322	9.63310	10.36690	10.03678	10.40368	45
16	9.59661	9.96316	9.63345	10.36655	10.03684	10.40339	44
17	9.59690	9.96311	9.63380	10.36621	10.03689	10.40310	43
18	9.59720	9.96305	9.63414	10.36586	10.03695	10.40280	42
19	9.59749	9.96300	9.63449	10.36551	10.03700	10.40251	41
20	9.59778	9.96295	9.63484	10.36516	10.03706	10.40222	40
21	9.59808	9.96289	9.63519	10.36482	10.03711	10.40193	39
22	9.59837	9.96284	9.63553	10.36447	10.03716	10.40163	38
23	9.59866	9.96278	9.63588	10.36412	10.03722	10.40134	37
24	9.59895	9.96273	9.63623	10.36377	10.03727	10.40105	36
25	9.59924	9.96267	9.63657	10.36343	10.03733	10.40076	35
26	9.59954	9.96262	9.63692	10.36308	10.03738	10.40046	34
27	9.59983	9.96256	9.63727	10.36274	10.03744	10.40017	33
28	9.60012	9.96251	9.63761	10.36239	10.03749	10.39988	32
29	9.60041	9.96245	9.63796	10.36204	10.03755	10.39959	31
30	9.60070	9.96240	9.63830	10.36170	10.03760	10.39930	30
		Sine.		Tang.		Secant.	Min.

66 *Degrees.*

Tangents, and Secants.

23 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.60070	9.96240	9.63830	10.36170	10.03760	10.39930	30
31	9.60099	9.96234	9.63865	10.36135	10.03766	10.39901	29
32	9.60128	9.96229	9.63899	10.36101	10.03771	10.39872	28
33	9.60157	9.96223	9.63934	10.36066	10.03777	10.39843	27
34	9.60186	9.96218	9.63968	10.36032	10.03782	16.39814	26
35	9.60215	9.96212	9.64003	10.35997	10.03788	10.39785	25
36	9.60244	9.96207	9.64037	10.35963	10.03793	10.39756	24
37	9.60273	9.96201	9.64072	10.35928	10.03799	10.39727	23
38	9.60302	9.96196	9.64106	10.35894	10.03804	10.39698	22
39	9.60331	9.96190	9.64140	10.35860	10.03810	10.39670	21
40	9.60359	9.96185	9.64175	10.35825	10.03815	10.39641	20
41	9.60388	9.96179	9.64209	10.35791	10.03821	10.39612	19
42	9.60417	9.96174	9.64243	10.35757	10.03826	10.39583	18
43	9.60446	9.96168	9.64278	10.35722	10.03832	10.39554	17
44	9.60475	9.96162	9.64312	10.35688	10.03838	10.39526	16
45	9.60503	9.96157	9.64346	10.35654	10.03843	10.39497	15
46	9.60532	9.96151	9.64381	10.35619	10.03849	10.39468	14
47	9.60561	9.96146	9.64415	10.35585	10.03854	10.39439	13
48	9.60589	9.96140	9.64449	10.35551	10.03860	10.39411	12
49	9.60618	9.96135	9.64483	10.35517	10.03865	10.39382	11
50	9.60647	9.96129	9.64517	10.35483	10.03871	10.39353	10
51	9.60675	9.96124	9.64552	10.35448	10.03877	10.39325	9
52	9.60704	9.96118	9.64586	10.35414	10.03882	10.39296	8
53	9.60732	9.96112	9.64620	10.35380	10.03888	10.39268	7
54	9.60761	9.96107	9.64654	10.35346	10.03893	10.39239	6
55	9.60789	9.96101	9.64688	10.35312	10.03899	10.39211	5
56	9.60818	9.96096	9.64722	10.35278	10.03905	10.39182	4
57	9.60846	9.96090	9.64756	10.35244	10.03910	10.39154	3
58	9.60875	9.96084	9.64790	10.35210	10.03916	10.39125	2
59	9.60903	9.96079	9.64824	10.35176	10.03921	10.39097	1
60	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	0
		Sine.		Tang.		Secant.	Min.

66 Degrees.

A Table of Artificial Sines,

24 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069	60
1	9.60960	9.96067	9.64892	10.35108	10.03933	10.39040	59
2	9.60988	9.96062	9.64926	10.35074	10.03938	10.39012	58
3	9.61016	9.96056	9.64960	10.35040	10.03944	10.38984	57
4	9.61045	9.96051	9.64994	10.35006	10.03950	10.38955	56
5	9.61073	9.96045	9.65028	10.34972	10.03955	10.38927	55
6	9.61101	9.96039	9.65062	10.34938	10.03961	10.38899	54
7	9.61129	9.96034	9.65096	10.34904	10.03967	10.38871	53
8	9.61158	9.96028	9.65130	10.34870	10.03972	10.38842	52
9	9.61186	9.96022	9.65164	10.34836	10.03978	10.38814	51
10	9.61214	9.96017	9.65197	10.34803	10.03983	10.38786	50
11	9.61242	9.96011	9.65231	10.34769	10.03989	10.38758	49
12	9.61270	9.96005	9.65265	10.34735	10.03995	10.38730	48
13	9.61298	9.96000	9.65299	10.34701	10.04001	10.38702	47
14	9.61326	9.95994	9.65333	10.34667	10.04006	10.38674	46
15	9.61355	9.95988	9.65366	10.34634	10.04012	10.38646	45
16	9.61383	9.95982	9.65400	10.34600	10.04018	10.38618	44
17	9.61411	9.95977	9.65434	10.34566	10.04023	10.38589	43
18	9.61439	9.95971	9.65467	10.34533	10.04029	10.38562	42
19	9.61467	9.95965	9.65501	10.34599	10.04035	10.38534	41
20	9.61494	9.95960	9.65535	10.34465	10.04040	10.38506	40
21	9.61522	9.95954	9.65568	10.34432	10.04046	10.38478	39
22	9.61550	9.95948	9.65602	10.34398	10.04052	10.38450	38
23	9.61578	9.95943	9.65636	10.34364	10.04058	10.38422	37
24	9.61606	9.95937	9.65669	10.34331	10.04063	10.38394	36
25	9.61634	9.95931	9.65703	10.34297	10.04069	10.38366	35
26	9.61662	9.95925	9.65736	10.34264	10.04075	10.38338	34
27	9.61689	9.95920	9.65770	10.34230	10.04081	10.38311	33
28	9.61717	9.95914	9.65803	10.34197	10.04086	10.38283	32
29	9.61745	9.95908	9.65837	10.34163	10.04092	10.38255	31
30	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
		Sine.		Tang.		Secant.	Min.

65 Degrees.

Tangents, and Secants.

25 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.61773	9.95902	9.65870	10.34130	10.04098	10.38227	30
31	9.61800	9.95897	9.65904	10.34096	10.04104	10.38200	29
32	9.61828	9.95891	9.65937	10.34063	10.04109	10.38172	28
33	9.61856	9.95885	9.65971	10.34029	10.04115	10.38144	27
34	9.61883	9.95879	9.66004	10.33996	10.04121	10.38117	26
35	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089	25
36	9.61939	9.95868	9.66071	10.33929	10.04132	10.38061	24
37	9.61966	9.95862	9.66104	10.33896	10.04138	10.38034	23
38	9.61994	9.95856	9.66138	10.33862	10.04144	10.38006	22
39	9.62021	9.95850	9.66171	10.33829	10.04150	10.37979	21
40	9.62049	9.95845	9.66204	10.33796	10.04156	10.37951	20
41	9.62076	9.95839	9.66238	10.33762	10.04161	10.37924	19
42	9.62104	9.95833	9.66271	10.33729	10.04167	10.37896	18
43	9.62131	9.95827	9.66304	10.33696	10.04173	10.37869	17
44	9.62159	9.95821	9.66337	10.33663	10.04179	10.37841	16
45	9.62186	9.95815	9.66371	10.33629	10.04185	10.37814	15
46	9.62214	9.95810	9.66404	10.33596	10.04190	10.37786	14
47	9.62241	9.95804	9.66437	10.33563	10.04196	10.37759	13
48	9.62268	9.95798	9.66470	10.33530	10.04202	10.37732	12
49	9.62296	9.95792	9.66504	10.33497	10.04208	10.37704	11
50	9.62323	9.95786	9.66537	10.33463	10.04214	10.37677	10
51	9.62350	9.95780	9.66570	10.33430	10.04220	10.37650	9
52	9.62377	9.95775	9.66603	10.33397	10.04225	10.37623	8
53	9.62405	9.95769	9.66636	10.33364	10.04231	10.37595	7
54	9.62432	9.95763	9.66669	10.33331	10.04237	10.37568	6
55	9.62459	9.95757	9.66702	10.33298	10.04243	10.37541	5
56	9.62486	9.95751	9.66735	10.33265	10.04249	10.37514	4
57	9.62514	9.95745	9.66768	10.33232	10.04255	10.37487	3
58	9.62541	9.95739	9.66801	10.33199	10.04261	10.37459	2
59	9.62568	9.95734	9.66834	10.33166	10.04267	10.37432	1
60	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	0
		Sine.		Tang.		Secant.	Min.

65 *Degrees.*

A Table of Artificial Sines,

25 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405	60
1	9.62622	9.95722	9.66900	10.33100	10.04278	10.37578	59
2	9.62649	9.95716	9.66933	10.33067	10.04284	10.37351	58
3	9.62676	9.95710	9.66966	10.33034	10.04290	10.37324	57
4	9.62703	9.95704	9.66999	10.33001	10.04296	10.37297	56
5	9.62730	9.95698	9.67032	10.32968	10.04302	10.37270	55
6	9.62757	9.95692	9.67065	10.32935	10.04308	10.37243	54
7	9.62784	9.95686	9.67098	10.32902	10.04314	10.37216	53
8	9.62811	9.95680	9.67131	10.32869	10.04320	10.37189	52
9	9.62838	9.95674	9.67163	10.32837	10.04326	10.37162	51
10	9.62865	9.95668	9.67196	10.32804	10.04332	10.37135	50
11	9.62892	9.95663	9.67229	10.32771	10.04338	10.37108	49
12	9.62918	9.95657	9.67202	10.32738	10.04343	10.37081	48
13	9.62945	9.95651	9.67295	10.32705	10.04349	10.37055	47
14	9.62972	9.95645	9.67327	10.32673	10.04355	10.37028	46
15	9.62999	9.95639	9.67360	10.32640	10.04361	10.37001	45
16	9.63026	9.95633	9.67393	10.32607	10.04367	10.36974	44
17	9.63052	9.95627	9.67426	10.32574	10.04373	10.36948	43
18	9.63079	9.95621	9.67458	10.32542	10.04379	10.36921	42
19	9.63106	9.95615	9.67491	10.32509	10.04385	10.36894	41
20	9.63133	9.95609	9.67524	10.32476	10.04391	10.36867	40
21	9.63159	9.95603	9.67556	10.32444	10.04397	10.36841	39
22	9.63186	9.95597	9.67589	10.32411	10.04403	10.36814	38
23	9.63213	9.95591	9.67622	10.32378	10.04409	10.36787	37
24	9.63239	9.95585	9.67654	10.32346	10.04415	10.36761	36
25	9.63266	9.95579	9.67687	10.32313	10.04421	10.36734	35
26	9.63292	9.95573	9.67719	10.32281	10.04427	10.36708	34
27	9.63319	9.95567	9.67752	10.32248	10.04433	10.36681	33
28	9.63345	9.95561	9.67785	10.32215	10.04439	10.36655	32
29	9.63372	9.95555	9.67817	10.32183	10.04445	10.36628	31
30	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
		Sine.		Tang.		Secant.	Min.

64 *Degrees.*

Tangents, and Secants.

25 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.63398	9.95549	9.67850	10.32150	10.04451	10.36602	30
31	9.63425	9.95543	9.67882	10.32118	10.04457	10.36575	29
32	9.63451	9.95537	9.67915	10.32085	10.04463	10.36549	28
33	9.63478	9.95531	9.67947	10.32053	10.04469	10.36522	27
34	9.63504	9.95525	9.67980	10.32021	10.04475	10.36496	26
35	9.63531	9.95519	9.68012	10.31988	10.04481	10.36469	25
36	9.63557	9.95513	9.68044	10.31956	10.04487	10.36443	24
37	9.63583	9.95507	9.68077	10.31923	10.04494	10.36417	23
38	9.63610	9.95501	9.68109	10.31891	10.04500	10.36390	22
39	9.63636	9.95494	9.68142	10.31858	10.04506	10.36364	21
40	9.63662	9.95488	9.68174	10.31826	10.04512	10.36338	20
41	9.63689	9.95482	9.68206	10.31794	10.04518	10.36311	19
42	9.63715	9.95476	9.68239	10.31761	10.04524	10.36285	18
43	9.63741	9.95470	9.68271	10.31729	10.04530	10.36259	17
44	9.63767	9.95464	9.68303	10.31697	10.04536	10.36233	16
45	9.63794	9.95458	9.68336	10.31664	10.04542	10.36206	15
46	9.63820	9.95452	9.68368	10.31632	10.04548	10.36180	14
47	9.63846	9.95446	9.68400	10.31600	10.04554	10.36154	13
48	9.63873	9.95440	9.68432	10.31568	10.04560	10.36128	12
49	9.63898	9.95434	9.68465	10.31535	10.04567	10.36102	11
50	9.63924	9.95427	9.68497	10.31503	10.04573	10.36076	10
51	9.63950	9.95421	9.68529	10.31471	10.04579	10.36050	9
52	9.63976	9.95415	9.68561	10.31439	10.04585	10.36024	8
53	9.64002	9.95409	9.68593	10.31407	10.04591	10.35998	7
54	9.64028	9.95403	9.68626	10.31375	10.04597	10.35972	6
55	9.64054	9.95397	9.68658	10.31342	10.04603	10.35946	5
56	9.64080	9.95391	9.68690	10.31310	10.04609	10.35920	4
57	9.64106	9.95385	9.68722	10.31278	10.04616	10.35894	3
58	9.64132	9.95378	9.68754	10.31246	10.04622	10.35868	2
59	9.64158	9.95372	9.68786	10.31214	10.04628	10.35842	1
60	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	0
		Sine.		Tang.		Secant.	Min.

64 *Degrees.*

A Table of Artificial Sines,

26 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.64184	9.95366	9.68818	10.31182	10.04634	10.35816	60
1	9.64210	9.95360	9.68850	10.31150	10.04640	10.35790	59
2	9.64236	9.95354	9.68882	10.31118	10.04646	10.35764	58
3	9.64262	9.95348	9.68914	10.31086	10.04653	10.35738	57
4	9.64288	9.95341	9.68946	10.31054	10.04659	10.35712	56
5	9.64314	9.95335	9.68978	10.31022	10.04665	10.35687	55
6	9.64339	9.95329	9.69010	10.30990	10.04671	10.35661	54
7	9.64365	9.95323	9.69042	10.30958	10.04677	10.35635	53
8	9.64391	9.95317	9.69074	10.30926	10.04683	10.35609	52
9	9.64417	9.95310	9.69106	10.30894	10.04690	10.35584	51
10	9.64442	9.95304	9.69138	10.30862	10.04696	10.35558	50
11	9.64468	9.95298	9.69170	10.30830	10.04702	10.35532	49
12	9.64494	9.95292	9.69202	10.30798	10.04708	10.35506	48
13	9.64519	9.95286	9.69234	10.30766	10.04715	10.35481	47
14	9.64545	9.95279	9.69266	10.30734	10.04721	10.35455	46
15	9.64571	9.95273	9.69298	10.30703	10.04727	10.35430	45
16	9.64596	9.95267	9.69329	10.30671	10.04733	10.35404	44
17	9.64622	9.95261	9.69361	10.30639	10.04739	10.35378	43
18	9.64647	9.95254	9.69393	10.30607	10.04746	10.35353	42
19	9.64673	9.95248	9.69425	10.30575	10.04752	10.35327	41
20	9.64698	9.95242	9.69457	10.30543	10.04758	10.35302	40
21	9.64724	9.95236	9.69488	10.30512	10.04764	10.35276	39
22	9.64749	9.95229	9.69520	10.30480	10.04771	10.35251	38
23	9.64775	9.95223	9.69552	10.30448	10.04777	10.35225	37
24	9.64800	9.95217	9.69584	10.30416	10.04783	10.35200	36
25	9.64826	9.95211	9.69615	10.30385	10.04789	10.35174	35
26	9.64851	9.95204	9.69647	10.30353	10.04796	10.35149	34
27	9.64877	9.95198	9.69679	10.30321	10.04802	10.35123	33
28	9.64902	9.95192	9.69710	10.30290	10.04808	10.35098	32
29	9.64927	9.95185	9.69742	10.30258	10.04815	10.35073	[illegible]
30	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	[illegible]
		Sine.		Tang.		Secant.	Min.

63 *Degrees.*

Tangents, and Secants.

26 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.64953	9.95179	9.69774	10.30226	10.04821	10.35047	30
31	9.64978	9.95173	9.69805	10.30195	10.04827	10.35022	29
32	9.65003	9.95167	9.69837	10.30163	10.04834	10.34997	28
33	9.65029	9.95160	9.69869	10.30132	10.04840	10.34971	27
34	9.65053	9.95154	9.69900	10.30100	10.04846	10.34946	26
35	9.65079	9.95148	9.69932	10.30068	10.04852	10.34921	25
36	9.65104	9.95141	9.69963	10.30037	10.04859	10.34896	24
37	9.65130	9.95135	9.69995	10.30005	10.04865	10.34870	23
38	9.65155	9.95129	9.70026	10.29974	10.04871	10.34845	22
39	9.65180	9.95122	9.70058	10.29942	10.04878	10.34820	21
40	9.65205	9.95116	9.70089	10.29911	10.04884	10.34795	20
41	9.65230	9.95110	9.70121	10.29879	10.04890	10.34770	19
42	9.65256	9.95103	9.70152	10.29848	10.04897	10.34745	18
43	9.65281	9.95097	9.70184	10.29816	10.04903	10.34719	17
44	9.65306	9.95091	9.70215	10.29785	10.04910	10.34694	16
45	9.65331	9.95084	9.70247	10.29753	10.04916	10.34669	15
46	9.65356	9.95078	9.70278	10.29722	10.04922	10.34644	14
47	9.65381	9.95071	9.70310	10.29691	10.04929	10.34619	13
48	9.65406	9.95065	9.70341	10.29659	10.04935	10.34594	12
49	9.65431	9.95059	9.70372	10.29628	10.04941	10.34569	11
50	9.65456	9.95052	9.70404	10.29596	10.04948	10.34544	10
51	9.65481	9.95046	9.70435	10.29565	10.04954	10.34519	9
52	9.65506	9.95039	9.70466	10.29534	10.04961	10.34494	8
53	9.65531	9.95033	9.70498	10.29502	10.04967	10.34469	7
54	9.65556	9.95027	9.70529	10.29471	10.04973	10.34444	6
55	9.65581	9.95020	9.70560	10.29440	10.04980	10.34420	5
56	9.65605	9.95014	9.70592	10.29408	10.04986	10.34395	4
57	9.65630	9.95007	9.70623	10.29377	10.04993	10.34370	3
58	9.65655	9.95001	9.70654	10.29346	10.04999	10.34345	2
59	9.65680	9.94995	9.70685	10.29315	10.05006	10.34320	1
60	9.65704	9.94988	9.70717	10.29383	10.05012	10.34295	0
Min.	[illegible]	Sine.		Tang.		Secant.	Min.

63 *Degrees.*

A Table of Artificial Sines,

27 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
1	9.65730	9.94982	9.70748	10.29252	10.05018	10.34270	59
2	9.65754	9.94975	9.70779	10.29221	10.05025	10.34246	58
3	9.65779	9.94969	9.70810	10.29190	10.05031	10.34221	57
4	9.65804	9.94962	9.70841	10.29159	10.05038	10.34196	56
5	9.65828	9 94956	9.70873	10.29127	10.05044	10.34172	55
6	9.65853	9.94949	9.70904	10.29096	10.05051	10.34147	54
7	9.65878	9.94943	9.70935	10.29065	10.05057	10.34122	53
8	9.65903	9.94936	9.70966	10.29034	10.05064	10.34098	52
9	9.65927	9.94930	9.70997	10.29003	10.05070	10.34073	51
10	9.65952	9.94924	9.71028	10.28972	10.05077	10.34048	50
11	9.65976	9.94917	9.71059	10.28941	10.05083	10.34024	49
12	9.66001	9.94911	9.71090	10.28910	10.05090	10.33999	48
13	9.66026	9.94904	9.71121	10.28879	10.05096	10.33975	47
14	9.66050	9.94898	9.71153	10.28848	10.05103	10.33950	46
15	9.66075	9.94891	9.71184	10.28816	10.05109	10.33925	45
16	9.66099	9.94885	9.71215	10.28785	10.05116	10.33901	44
17	9.66124	9.94878	9.71246	10.28754	10.05122	10.33876	43
18	9.66148	9.94872	9.71277	10.28723	10.05129	10.33852	42
19	9.66173	9.94865	9.71308	10.28692	10.05135	10.33827	41
20	9.66197	9.94858	9.71339	10.28661	10.05142	10.33803	40
21	9.66221	9.94852	9.71370	10.28630	10.05148	10.33779	39
22	9.66246	9.94845	9.71401	10.28600	10.05155	10.33754	38
23	9.66270	9.94839	9.71431	10.28569	10.05161	10.33730	37
24	9.66295	9.94832	9.71462	10.28538	10.05168	10.33705	36
25	9.66319	9.94826	9.71493	10.28507	10.05174	10.33681	35
26	9.66343	9.94819	9.71524	10.28476	10.05181	10.33657	34
27	9.66368	9.94813	9.71555	10.28445	10.05187	10.33632	33
28	9.66392	9.94806	9.71586	10.28414	10.05194	10.33608	32
29	9.66416	9.94800	9.71617	10.28383	10.05201	10.33584	31
30	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
		Sine.		Tang.		Secant.	Min.

62 *Degrees.*

Tangents, and Secants.

27 Degrees.

Min.	Sine.		Tang.		Secant.		
30	9.66441	9.94793	9.71648	10.28352	10.05207	10.33559	30
31	9.66465	9.94786	9.71679	10.28322	10.05214	10.33535	29
32	9.66489	9.94780	9.71709	10.28291	10.05220	10.33511	28
33	9.66513	9.94773	9.71740	10.28260	10.05227	10.33487	27
34	9.66538	9.94767	9.71771	10.28229	10.05233	10.33462	26
35	9.66562	9.94760	9.71802	10.28198	10.05240	10.33438	25
36	9.66586	9.94753	9.71833	10.28168	10.05247	10.33414	24
37	9.66610	9.94747	9.71863	10.28137	10.05253	10.33390	23
38	9.66634	9.94740	9.71894	10.28106	10.05260	10.33366	22
39	9.66658	9.94734	9.71925	10.28075	10.05267	10.33342	21
40	9.66682	9.94727	9.71956	10.28045	10.05273	10.33318	20
41	9.66707	9.94720	9.71986	10.28014	10.05280	10.33294	19
42	9.66731	9.94714	9.72017	10.27983	10.05286	10.33269	18
43	9.66755	9.94707	9.72048	10.27952	10.05293	10.33245	17
44	9.66779	9.94700	9.72078	10.27922	10.05300	10.33221	16
45	9.66803	9.94694	9.72109	10.27891	10.05306	10.33197	15
46	9.66827	9.94687	9.72139	10.27860	10.05313	10.33173	14
47	9.66851	9.94680	9.72170	10.27830	10.05320	10.33149	13
48	9.66875	9.94674	9.72201	10.27799	10.05326	10.33125	12
49	9.66899	9.94667	9.72232	10.27769	10.05333	10.33101	11
50	9.66923	9.94660	9.72262	10.27738	10.05340	10.33078	10
51	9.66946	9.94654	9.72293	10.27707	10.05346	10.33054	9
52	9.66970	9.94647	9.72323	10.27677	10.05353	10.33030	8
53	9.66994	9.94640	9.72354	10.27646	10.05360	10.33006	7
54	9.67018	9.94634	9.72384	10.27616	10.05366	10.32982	6
55	9.67042	9.94627	9.72415	10.27585	10.05373	10.32958	5
56	9.67066	9.94620	9.72445	10.27555	10.05380	10.32934	4
57	9.67090	9.94614	9.72476	10.27524	10.05386	10.32910	3
58	9.67113	9.94607	9.72507	10.27494	10.05393	10.32887	2
59	9.67137	9.94600	9.72537	10.27463	10.05400	10.32863	1
60	9.67161	9.94594	9.72567	10.27433	10.05407	10.32839	0
		Sine.		Tang.		Secant.	Min.

62 Degrees.

A Table of Artificial Sines,

28 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.67161	9.94594	9.72567	10.27433	10.05407	10.32839	60
1	9.67185	9.94587	9.72598	10.27402	10.05413	10.32815	59
2	9.67208	9.94580	9.72628	10.27372	10.05420	10.32792	58
3	9.67232	9.94573	9.72659	10.27341	10.05427	10.32768	57
4	9.67256	9.94567	9.72689	10.27311	10.05433	10.32744	56
5	9.67280	9.94560	9.72720	10.27280	10.05440	10.32721	55
6	9.67303	9.94553	9.72750	10.27250	10.05447	10.32697	54
7	9.67327	9.94546	9.72781	10.27220	10.05454	10.32673	53
8	9.67351	9.94540	9.72811	10.27189	10.05460	10.32650	52
9	9.67374	9.94533	9.72841	10.27159	10.05467	10.32626	51
10	9.67398	9.94526	9.72872	10.27128	10.05474	10.32602	50
11	9.67421	9.94519	9.72902	10.27098	10.05481	10.32579	49
12	9.67445	9.94513	9.72932	10.27068	10.05487	10.32555	48
13	9.67468	9.94506	9.72963	10.27037	10.05494	10.32532	47
14	9.67492	9.94499	9.72993	10.27007	10.05501	10.32508	46
15	9.67516	9.94492	9.73023	10.26977	10.05508	10.32485	45
16	9.67539	9.94485	9.73054	10.26947	10.05515	10.32461	44
17	9.67562	9.94479	9.73084	10.26916	10.05521	10.32438	43
18	9.67586	9.94472	9.73114	10.26886	10.05528	10.32414	42
19	9.67609	9.94465	9.73144	10.26856	10.05535	10.32391	41
20	9.67633	9.94458	9.73175	10.26825	10.05542	10.32367	40
21	9.67656	9.94451	9.73205	10.26795	10.05549	10.32344	39
22	9.67680	9.94445	9.73235	10.26765	10.05555	10.32320	38
23	9.67703	9.94438	9.73265	10.26735	10.05562	10.32297	37
24	9.67726	9.94431	9.73296	10.26705	10.05569	10.32274	36
25	9.67750	9.94424	9.73326	10.26674	10.05576	10.32250	35
26	9.67773	9.94417	9.73356	10.26644	10.05583	10.32227	34
27	9.67796	9.94410	9.73386	10.26614	10.05590	10.32204	33
28	9.67820	9.94404	9.73416	10.26584	10.05596	10.32180	32
29	9.67843	9.94397	9.73446	10.26554	10.05603	10.32157	31
30	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
		Sine.		Tang.		Secant.	Min.

61 *Degrees.*

Tangents, and Secants.

28 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.67866	9.94390	9.73476	10.26524	10.05610	10.32134	30
31	9.67890	9.94383	9.73507	10.26493	10.05617	10.32110	29
32	9.67913	9.94376	9.73537	10.26463	10.05624	10.32087	28
33	9.67936	9.94369	9.73567	10.26433	10.05631	10.32064	27
34	9.67959	9.94362	9.73597	10.26403	10.05638	10.32041	26
35	9.67982	9.94356	9.73627	10.26373	10.05645	10.32018	25
36	9.68006	9.94349	9.73657	10.26343	10.05651	10.31994	24
37	9.68029	9.94342	9.73687	10.26313	10.05658	10.31971	23
38	9.68052	9.94335	9.73717	10.26283	10.05665	10.31948	22
39	9.68075	9.94328	9.73747	10.26253	10.05672	10.31925	21
40	9.68098	9.94321	9.73777	10.26223	10.05679	10.31902	20
41	9.68121	9.94314	9.73807	10.26193	10.05686	10.31879	19
42	9.68144	9.94307	9.73837	10.26163	10.05693	10.31856	18
43	9.68167	9.94300	9.73867	10.26133	10.05700	10.31833	17
44	9.68191	9.94293	9.73897	10.26103	10.05707	10.31810	16
45	9.68214	9.94286	9.73927	10.26073	10.05714	10.31787	15
46	9.68237	9.94280	9.73957	10.26043	10.05721	10.31764	14
47	9.68260	9.94273	9.73987	10.26013	10.05727	10.31741	13
48	9.68283	9.94266	9.74017	10.25983	10.05734	10.31718	12
49	9.68306	9.94259	9.74047	10.25953	10.05741	10.31695	11
50	9.68328	9.94252	9.74077	10.25923	10.05748	10.31672	10
51	9.68351	9.94245	9.74107	10.25893	10.05755	10.31649	9
52	9.68374	9.94238	9.74137	10.25864	10.05762	10.31626	8
53	9.68397	9.94231	9.74166	10.25834	10.05769	10.31603	7
54	9.68420	9.94224	9.74196	10.25804	10.05776	10.31580	6
55	9.68443	9.94217	9.74226	10.25774	10.05783	10.31557	5
56	9.68466	9.94210	9.74256	10.25744	10.05790	10.31534	4
57	9.68489	9.94203	9.74286	10.25714	10.05797	10.31511	3
58	9.68512	9.94196	9.74316	10.25684	10.05804	10.31489	2
59	9.68534	9.94189	9.74345	10.25655	10.05811	10.31466	1
60	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	0
		Sine.		Tang.		Secant.	Min.

61 *Degrees.*

A Table of Artificial Sines,

29 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
1	9.68580	9.94175	9.74405	10.25595	10.05825	10.31420	59
2	9.68603	9.94168	9.74435	10.25565	10.05832	10.31397	58
3	9.68625	9.94161	9.74465	10.25536	10.05839	10.31375	57
4	9.68648	9.94154	9.74494	10.25506	10.05846	10.31352	56
5	9.68671	9.94147	9.74524	10.25476	10.05853	10.31329	55
6	9.68694	9.94140	9.74554	10.25446	10.05860	10.31306	54
7	9.68716	9.94133	9.74584	10.25417	10.05867	10.31284	53
8	9.68739	9.94126	9.74613	10.25387	10.05874	10.31261	52
9	9.68762	9.94119	9.74643	10.25357	10.05881	10.31238	51
10	9.68784	9.94112	9.74673	10.25327	10.05888	10.31216	50
11	9.68807	9.94105	9.74702	10.25298	10.05895	10.31193	49
12	9.68830	9.94098	9.74732	10.25268	10.05902	10.31171	48
13	9.68852	9.94091	9.74762	10.25238	10.05910	10.31148	47
14	9.68875	9.94083	9.74791	10.25209	10.05917	10.31125	46
15	9.68897	9.94076	9.74821	10.25179	10.05924	10.31103	45
16	9.68920	9.94069	9.74851	10.25150	10.05931	10.31080	44
17	9.68942	9.94062	9.74880	10.25120	10.05938	10.31058	43
18	9.68965	9.94055	9.74910	10.25090	10.05945	10.31035	42
19	9.68987	9.94048	9.74939	10.25061	10.05952	10.31013	41
20	9.69010	9.94041	9.74969	10.25031	10.05959	10.30990	40
21	9.69032	9.94034	9.74999	10.25002	10.05966	10.30968	39
22	9.69055	9.94027	9.75028	10.24972	10.05973	10.30945	38
23	9.69077	9.94020	9.75058	10.24942	10.05980	10.30923	37
24	9.69100	9.94013	9.75087	10.24913	10.05988	10.30900	36
25	9.69122	9.94005	9.75117	10.24883	10.05995	10.30878	35
26	9.69144	9.93998	9.75146	10.24854	10.06002	10.30856	34
27	9.69167	9.93991	9.75176	10.24824	10.06009	10.30833	33
28	9.69189	9.93984	9.75205	10.24795	10.06016	10.30811	32
29	9.69212	9.93977	9.75235	10.24765	10.06023	10.30788	31
30	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
		Sine.		Tang.		Secant.	Min.

60 Degrees.

Tangents, and Secants.

29 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.69234	9.93970	9.75264	10.24736	10.06030	10.30766	30
31	9.69256	9.93963	9.75294	10.24706	10.06038	10.30734	29
32	9.69279	9.93955	9.75323	10.24677	10.06045	10.30721	28
33	9.69301	9.93948	9.75353	10.24647	10.06052	10.30699	27
34	9.69323	9.93941	9.75382	10.24618	10.06059	10.30677	26
35	9.69345	9.93934	9.75412	10.24589	10.06066	10.30655	25
36	9.69368	9.93927	9.75441	10.24559	10.06073	10.30632	24
37	9.69390	9.93919	9.75470	10.24530	10.06080	10.30610	23
38	9.69412	9.93912	9.75500	10.24500	10.06088	10.30588	22
39	9.69434	9.93905	9.75529	10.24471	10.06095	10.30566	21
40	9.69456	9.93898	9.75558	10.24442	10.06102	10.30544	20
41	9.69479	9.93891	9.75588	10.24412	10.06109	10.30521	19
42	9.69501	9.93884	9.75617	10.24383	10.06116	10.30499	18
43	9.69523	9.93876	9.75647	10.24354	10.06124	10.30477	17
44	9.69545	9.93869	9.75676	10.24324	10.06131	10 30455	16
45	9.69567	9.93862	9.75705	10.24295	10.06138	10.30433	15
46	9.69589	9.93855	9.75735	10.24266	10.06145	10.30411	14
47	9.69611	9.93848	9.75764	10.24236	10.06153	10.30389	13
48	9.69633	9.93840	9.75793	10.24207	10.06160	10.30367	12
49	9.69655	9.93833	9.75822	10.24178	10.06167	10.30345	11
50	9.69677	9.93826	9.75852	10.24148	10.06174	10.30323	10
51	9.69700	9.93819	9.75881	10.24119	10.06182	10.30301	9
52	9.69722	9.93811	9.75910	10.24090	10.06189	10.30279	8
53	9.69744	9.93804	9.75940	10.24061	10.06196	10.30257	7
54	9.69765	9.93797	9.75969	10.24031	10.06203	10.30235	6
55	9.69787	9.93790	9.75998	10.24002	10.06211	10.30213	5
56	9.69809	9.93782	9.76027	10.23973	10.06218	10.30191	4
57	9.69831	9.93775	9.76056	10.23944	10.06225	10.30169	3
58	9.69853	9.93768	9.76086	10.23914	10.06232	10.30147	2
59	9.69875	9.93760	9.76115	10.23885	10.06240	10.30125	1
60	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	0
		Sine.		Tang.		Secant.	Min.

60 *Degrees.*

A Table of Artificial Sines,

30 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	60
1	9.69919	9.93746	9.76173	10.23827	10.06254	10.30081	59
2	9.69941	9.93739	9.76202	10.23798	10.06262	10.30059	58
3	9.69963	9.93731	9.76231	10.23769	10.06269	10.30037	57
4	9.69984	9.93724	9.76261	10.23776	10.06276	10.30016	56
5	9.70006	9.93717	9.76290	10.23710	10.06284	10.29994	55
6	9.70028	9.93709	9.76319	10.23681	10.06291	10.29972	54
7	9.70050	9.93702	9.76348	10.23652	10.06298	10.29950	53
8	9.70072	9.93695	9.76377	10.23623	10.06305	10.29928	52
9	9.70093	9.93687	9.76406	10.23594	10.06311	10.29907	51
10	9.70115	9.93680	9.76435	10.23565	10.06320	10.29885	50
11	9.70137	9.93673	9.76464	10.23536	10.06328	10.29863	49
12	9.70159	9.93665	9.76493	10.23507	10.06335	10.29842	48
13	9.70180	9.93658	9.76522	10.23478	10.06342	10.29820	47
14	9.70202	9.93651	9.76551	10.23449	10.06350	10.29798	46
15	9.70224	9.93643	9.76581	10.23420	10.06357	10.29776	45
16	9.70245	9.93636	9.76610	10.23391	10.06364	10.29755	44
17	9.70267	9.93628	9.76639	10.23362	10.06372	10.29733	43
18	9.70289	9.93621	9.76668	10.23333	10.06379	10.29712	42
19	9.70310	9.93614	9.76697	10.23304	10.06386	10.29690	41
20	9.70332	9.93606	9.76726	10.23275	10.06394	10.29668	40
21	9.70353	9.93599	9.76755	10.23246	10.06401	10.29647	39
22	9.70375	9.93591	9.76783	10.23217	10.06409	10.29625	38
23	9.70396	9.93584	9.76812	10.23188	10.06416	10.29604	37
24	9.70418	9.93577	9.76841	10.23159	10.06423	10.29582	36
25	9.70440	9.93569	9.76870	10.23130	10.06431	10.29561	35
26	9.70461	9.93562	9.76899	10.23101	10.06438	10.29539	34
27	9.70483	9.93554	9.76928	10.23072	10.06446	10.29518	33
28	9.70504	9.93547	9.76957	10.23043	10.06453	10.29496	32
29	9.70525	9.93540	9.76986	10.23014	10.06461	10.29475	31
30	9.70547	9.93532	9.76015	10.22985	10.06468	10.29453	30
		Sine.		Tang.		Secant.	Min.

59 *Degrees.*

Tangents, and Secants.

30 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.70547	9.93532	9.77015	10.22985	10.06468	10.29453	30
31	9.70568	9.93525	9.77044	10.22956	10.06475	10.29432	29
32	9.70590	9.93517	9.77073	10.22927	10.06483	10.29410	28
33	9.70611	9.93510	9.77102	10.22899	10.06490	10.29389	27
34	9.70633	9.93502	9.77130	10.22870	10.06498	10.29367	26
35	9.70654	9.93495	9.77159	10.22841	10.06505	10.29346	25
36	9.70675	9.93487	9.77188	10.22812	10.06513	10.29325	24
37	9.70697	9.93480	9.77217	10.22783	10.06520	10.29303	23
38	9.70718	9.93472	9.77246	10.22754	10.06528	10.29282	22
39	9.70739	9.93465	9.77275	10.22726	10.06535	10.29261	21
40	9.70761	9.93457	9.77303	10.22697	10.06543	10.29239	20
41	9.70782	9.93450	9.77332	10.22668	10.06550	10.29218	19
42	9.70803	9.93442	9.77361	10.22639	10.06558	10.29197	18
43	9.70825	9.93435	9.77390	10.22610	10.06565	10.29175	17
44	9.70846	9.93427	9.77418	10.22582	10.06573	10.29154	16
45	9.70867	9.93420	9.77447	10.22553	10.06580	10.29133	15
46	9.70888	9.93412	9.77476	10.22524	10.06588	10.29112	14
47	9.70909	9.93405	9.77505	10.22495	10.06595	10.29091	13
48	9.70931	9.93397	9.77533	10.22467	10.06603	10.29069	12
49	9.70952	9.93390	9.77562	10.22438	10.06610	10.29048	11
50	9.70973	9.93382	9.77591	10.22409	10.06618	10.29027	10
51	9.70994	9.93375	9.77620	10.22381	10.06625	10.29006	9
52	9.71015	9.93367	9.77648	10.22352	10.06633	10.28985	8
53	9.71036	9.93360	9.77677	10.22323	10.06640	10.28964	7
54	9.71058	9.93352	9.77706	10.22295	10.06648	10.28943	6
55	9.71079	9.93344	9.77734	10.22266	10.06656	10.28921	5
56	9.71100	9.93337	9.77763	10.22237	10.06663	10.28900	4
57	9.71121	9.93329	9.77792	10.22209	10.06671	10.28879	3
58	9.71142	9.93322	9.77820	10.22180	10.06678	10.28858	2
59	9.71163	9.93314	9.77849	10.22151	10.06686	10.28837	1
60	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	0
		Sine.		Tang.		Secant.	Min.

59 *Degrees.*

A Table of Artificial Sines,

31 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
1	9.71205	9.93299	9.77906	10.22094	10.06701	10.28795	59
2	9.71226	9.93291	9.77935	10.22065	10.06709	10.28774	58
3	9.71247	9.93284	9.77963	10.22037	10.06716	10.28753	57
4	9.71268	9.93276	9.77992	10.22008	10.06724	10.28732	56
5	9.71289	9.93269	9.78020	10.21980	10.06732	10.28711	55
6	9.71310	9.93261	9.78049	10.21951	10.06739	10.28690	54
7	9.71331	9.93253	9.78078	10.21923	10.06747	10.28669	53
8	9.71352	9.93246	9.78106	10.21894	10.06754	10.28648	52
9	9.71373	9.93238	9.78135	10.21865	10.06762	10.28627	51
10	9.71394	9.93230	9.78163	10.21837	10.06770	10.28607	50
11	9.71414	9.93223	9.78192	10.21808	10.06777	10.28586	49
12	9.71435	9.93215	9.78220	10.21780	10.06785	10.28565	48
13	9.71456	9.93207	9.78249	10.21751	10.06793	10.28544	47
14	9.71477	9.93200	9.78277	10.21723	10.06800	10.28523	46
15	9.71498	9.93192	9.78306	10.21694	10.06808	10.28502	45
16	9.71519	9.93185	9.78334	10.21666	10.06816	10.28481	44
17	9.71539	9.93177	9.78363	10.21637	10.06823	10.28461	43
18	9.71560	9.93169	9.78391	10.21609	10.06831	10.28440	42
19	9.71581	9.93161	9.78419	10.21581	10.06839	10.28419	41
20	9.71602	9.93154	9.78448	10.21552	10.06846	10.28398	40
21	9.71622	9.93146	9.78476	10.21524	10.06854	10.28378	39
22	9.71643	9.93138	9.78505	10.21495	10.06862	10.28357	38
23	9.71664	9.93131	9.78533	10.21467	10.06869	10.28336	37
24	9.71685	9.93123	9.78562	10.21438	10.06877	10.28315	36
25	9.71705	9.93115	9.78590	10.21410	10.06885	10.28295	35
26	9.71726	9.93108	9.78618	10.21382	10.06893	10.28274	34
27	9.71747	9.93100	9.78647	10.21353	10.06900	10.28253	33
28	9.71767	9.93092	9.78675	10.21325	10.06908	10.28233	32
29	9.71788	9.93084	9.78704	10.21296	10.06916	10.28212	31
30	9.71809	9.93077	9.78732	10.21268	10.06923	10.28192	30
		Sine.		Tang.		Secant.	Min.

58 *Degrees.*

Tangents, and Secants.

31 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.71809	9.93077	9.78732	10.21268	10.06923	10.28191	30
31	9.71829	9.93069	9.78760	10.21240	10.06931	10.28171	29
32	9.71850	9.93061	9.78789	10.21211	10.06939	10.28150	28
33	9.71870	9.93053	9.78817	10.21183	10.06947	10.28130	27
34	9.71891	9.93046	9.78845	10.21155	10.06954	10.28109	26
35	9.71911	9.93038	9.78874	10.21126	10.06962	10.28089	25
36	9.71932	9.93030	9.78902	10.21098	10.06970	10.28068	24
37	9.71953	9.93022	9.78930	10.21070	10.06978	10.28048	23
38	9.71973	9.93015	9.78959	10.21042	10.06986	10.28027	22
39	9.71994	9.93007	9.78987	10.21013	10.06993	10.28007	21
40	9.72014	9.92999	9.79015	10.20985	10.07001	10.27986	20
41	9.72035	9.92991	9.79043	10.20957	10.07009	10.27966	19
42	9.72055	9.92983	9.79072	10.20928	10.07017	10.27945	18
43	9.72075	9.92976	9.79100	10.20900	10.07025	10.27925	17
44	9.72096	9.92968	9.79128	10.20872	10.07032	10.27904	16
45	9.72116	9.92960	9.79156	10.20844	10.07040	10.27884	15
46	9.72137	9.92952	9.79185	10.20815	10.07048	10.27863	14
47	9.72157	9.92944	9.79213	10.20787	10.07056	10.27843	13
48	9.72177	9.92936	9.79241	10.20759	10.07064	10.27823	12
49	9.72198	9.92929	9.79269	10.20731	10.07071	10.27802	11
50	9.72218	9.92921	9.79297	10.20703	10.07079	10.27782	10
51	9.72239	9.92913	9.79326	10.20674	10.07087	10.27761	9
52	9.72259	9.92905	9.79354	10.20646	10.07095	10.27741	8
53	9.72279	9.92897	9.79382	10.20618	10.07103	10.27721	7
54	9.72299	9.92889	9.79410	10.20590	10.07111	10.27701	6
55	9.72320	9.92881	9.79438	10.20562	10.07118	10.27680	5
56	9.72340	9.92874	9.79466	10.20534	10.07126	10.27660	4
57	9.72360	9.92866	9.79495	10.20505	10.07134	10.27640	3
58	9.72381	9.92858	9.79523	10.20477	10.07142	10.27620	2
59	9.72401	9.92850	9.79551	10.20449	10.07150	10.27599	1
60	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	0
		Sine.		Tang.		Secant.	Min.

58 *Degrees.*

A Table of Artificial Sines,

32 Degrees.

Min.	Sine.		Tang.		Secant.		
0	9.72421	9.92842	9.79579	10.20421	10.07158	10.27579	60
1	9.72441	9.92834	9.79607	10.20393	10.07166	10.27559	59
2	9.72461	9.92826	9.79635	10.20365	10.07174	10.27539	58
3	9.72482	9.92818	9.79663	10.20337	10.07182	10.27518	57
4	9.72502	9.92810	9.79691	10.20309	10.07190	10.27498	56
5	9.72522	9.92803	9.79719	10.20281	10.07198	10.27478	55
6	9.72542	9.92795	9.79747	10.20253	10.07205	10.27458	54
7	9.72562	9.92787	9.79776	10.20225	10.07213	10.27438	53
8	9.72582	9.92779	9.79804	10.20196	10.07221	10.27418	52
9	9.72602	9.92771	9.79832	10.20168	10.07229	10.27398	51
10	9.72623	9.92763	9.79860	10.20140	10.07237	10.27378	50
11	9.72643	9.92755	9.79888	10.20112	10.07245	10.27357	49
12	9.72663	9.92747	9.79916	10.20084	10.07253	10.27337	48
13	9.72683	9.92739	9.79944	10.20056	10.07261	10.27317	47
14	9.72703	9.92731	9.79972	10.20028	10.07269	10.27297	46
15	9.72723	9.92723	9.80000	10.20000	10.07277	10.27277	45
16	9.72743	9.92715	9.80028	10.19972	10.07285	10.27257	44
17	9.72763	9.92707	9.80056	10.19944	10.07293	10.27237	43
18	9.72783	9.92699	9.80084	10.19916	10.07301	10.27217	42
19	9.72803	9.92691	9.80112	10.19888	10.07309	10.27197	41
20	9.72823	9.92683	9.80140	10.19860	10.07317	10.27177	40
21	9.72843	9.92675	9.80168	10.19833	10.07325	10.27157	39
22	9.72863	9.92667	9.80196	10.19805	10.07333	10.27137	38
23	9.72883	9.92659	9.80223	10.19777	10.07341	10.27118	37
24	9.72802	9.92651	9.80251	10.19749	10.07349	10.27098	36
25	9.72922	9.92643	9.80279	10.19721	10.07357	10.27078	35
26	9.72942	9.92635	9.80307	10.19693	10.07365	10.27058	34
27	9.72962	9.92627	9.80335	10.19665	10.07373	10.27038	33
28	9.72982	9.92619	9.80363	10.19637	10.07381	10.27018	32
29	9.73002	9.92611	9.80391	10.19609	10.07389	10.26998	31
30	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
		Sine.		Tang.		Secant.	Min.

57 Degrees.

Tangents, and Secants.

32 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.73022	9.92603	9.80419	10.19581	10.07397	10.26978	30
31	9.73032	9.92595	9.80447	10.19553	10.07405	10.26959	29
32	9.73061	9.92587	9.80475	10.19526	10.07413	10.26939	28
33	9.73081	9.92579	9.80502	10.19498	10.07421	10.26919	27
34	9.73101	9.92571	9.80530	10.19470	10.07429	10.26899	26
35	9.73121	9.92593	9.80558	10.19442	10.07437	10.26879	25
36	9.73140	9.92555	9.80586	10.19414	10.07446	10.26860	24
37	9.73160	9.92547	9.80614	10.19386	10.07454	10.26840	23
38	9.73180	9.92538	9.80642	10.19359	10.07462	10.26820	22
39	9.73200	9.92530	9.80669	10.19331	10.07470	10.26800	21
40	9.73219	9.92522	9.80697	10.19303	10.07478	10.26781	20
41	9.73239	9.92514	9.80725	10.19275	10.07486	10.26761	19
42	9.73259	9.92505	9.80753	10.19247	10.07494	10.26741	18
43	9.73278	9.92498	9.80781	10.19220	10.07502	10.26722	17
44	9.73298	9.92490	9.80808	10.19192	10.07510	10.26702	16
45	9.73318	9.92482	9.80836	10.19164	10.07518	10.26682	15
46	9.73337	9.92474	9.80864	10.19136	10.07527	10.26663	14
47	9.73357	9.92465	9.80892	10.19108	10.07534	10.26643	13
48	9.73377	9.92457	9.80919	10.19081	10.07543	10.26624	12
49	9.73396	9.92449	9.80947	10.19053	10.07551	10.26604	11
50	9.73416	9.92441	9.80975	10.19025	10.07559	10.26584	10
51	9.73435	9.92433	9.81003	10.18998	10.07567	10.26565	9
52	9.73455	9.92425	9.81030	10.18970	10.07575	10.26545	8
53	9.73474	9.92416	9.81058	10.18942	10.07584	10.26526	7
54	9.73494	9.92408	9.81086	10.18914	10.07592	10.26506	6
55	9.73513	9.92401	9.81113	10.18887	10.07600	10.26487	5
56	9.73533	9.92392	9.81141	10.18859	10.07608	10.26467	4
57	9.73553	9.92384	9.81169	10.18831	10.07616	10.26448	3
58	9.73572	9.92376	9.81196	10.18804	10.07625	10.26428	2
59	9.73591	9.92367	9.81224	10.18776	10.07633	10.26409	1
60	9.73611	9.92359	9.81252	10.18748	10.07641	10.26389	0
		Sine.		Tang.		Secant.	Min.

57 *Degrees.*

A Table of Artificial Sines,

33 *Degrees,*

Min.	Sine.		Tang.		Secant.		
0	9.73611	9.92359	9.81252	10.18748	10.07641	10.26389	60
1	9.73630	9.92351	9.81279	10.18721	10.07649	10.26370	59
2	9.73650	9.92343	9.81307	10.18693	10.07657	10.26350	58
3	9.73669	9.92335	9.81335	10.18665	10.07666	10.26331	57
4	9.73689	9.92326	9.81362	10.18638	10.07674	10.26311	56
5	9.73708	9.92318	9.81390	10.18610	10.07682	10.26292	55
6	9.73727	9.92310	9.81418	10.18582	10.07690	10.26273	54
7	9.73747	9.92302	9.81445	10.18555	10.07698	10.26253	53
8	9.73766	9.92293	9.81473	10.18527	10.07706	10.26234	52
9	9.73785	9.92285	9.81500	10.18500	10.07715	10.26215	51
10	9.73805	9.92277	9.81528	10.18472	10.07723	10.26195	50
11	9.73824	9.92269	9.81556	10.18445	10.07731	10.26176	49
12	9.73843	9.92260	9.81583	10.18417	10.07740	10.26157	48
13	9.73863	9.92252	9.81611	10.18389	10.07748	10.26137	47
14	9.73882	9.92244	9.81638	10.18362	10.07756	10.26118	46
15	9.73901	9.92236	9.81666	10.18334	10.07765	10.26099	45
16	9.73921	9.92227	9.81693	10.18307	10.07773	10.26079	44
17	9.73940	9.92219	9.81721	10.18279	10.07781	10.26060	43
18	9.73959	9.92211	9.81748	10.18252	10.07789	10.26041	42
19	9.73978	9.92202	9.81776	10.18224	10.07798	10.26022	41
20	9.73998	9.92194	9.81804	10.18197	10.07806	10.26003	40
21	9.74017	9.92186	9.81831	10.18169	10.07814	10.25983	39
22	9.74036	9.92177	9.81859	10.18142	10.07823	10.25964	38
23	9.74055	9.92169	9.81886	10.18114	10.07831	10.25945	37
24	9.74074	9.92161	9.81913	10.18087	10.07839	10.25926	36
25	9.74093	9.92152	9.81941	10.18059	10.07848	10.25907	35
26	9.74113	9.92144	9.81968	10.18032	10.07856	10.25888	34
27	9.74132	9.92136	9.81996	10.18004	10.07864	10.25868	33
28	9.74151	9.92127	9.82023	10.17977	10.07873	10.25849	32
29	9.74170	9.92119	9.82051	10.17949	10.07881	10.25830	31
30	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
		Sine.		Tang.		Secant.	Min.

56 *Degrees.*

Tangents, and Secants.

33 *Degrees.*

Min.	Sine	~~Sine~~	Tang.		Secant.		
30	9.74189	9.92111	9.82078	10.17922	10.07889	10.25811	30
31	9.74208	9.92102	9.82106	10.17894	10.07898	10.25792	29
32	9.74227	9.92094	9.82133	10.17867	10.07906	10.25773	28
33	9.74246	9.92086	9.82161	10.17839	10.07914	10.25754	27
34	9.74265	9.92077	9.82188	10.17812	10.07923	10.25735	26
35	9.74284	9.92068	9.82215	10.17785	10.07931	10.25716	25
36	9.74303	9.92060	9.82243	10.17757	10.07940	10.25697	24
37	9.74322	9.92052	9.82270	10.17730	10.07948	10.25678	23
38	9.74341	9.92044	9.82298	10.17702	10.07956	10.25659	22
39	9.74360	9.92035	9.82325	10.17675	10.07965	10.25640	21
40	9.74379	9.92027	9.82352	10.17648	10.07973	10.25621	20
41	9.74398	9.92018	9.82380	10.17620	10.07982	10.25602	19
42	9.74417	9.92010	9.82407	10.17593	10.07990	10.25583	18
43	9.74436	9.92002	9.82435	10.17565	10.07999	10.25564	17
44	9.74455	9.91993	9.82462	10.17538	10.08007	10.25545	16
45	9.74474	9.91985	9.82489	10.17511	10.08015	10.25526	15
46	9.74493	9.91976	9.82517	10.17483	10.08024	10.25507	14
47	9.74512	9.91968	9.82544	10.17456	10.08032	10.25488	13
48	9.74531	9.91959	9.82571	10.17429	10.08041	10.25469	12
49	9.74549	9.91951	9.82599	10.17401	10.08049	10.25451	11
50	9.74568	9.91942	9.82626	10.17374	10.08058	10.25432	10
51	9.74587	9.91934	9.82653	10.17347	10.08066	10.25413	9
52	9.74606	9.91925	9.82681	10.17320	10.08075	10.25394	8
53	9.74625	9.91917	9.82708	10.17292	10.08083	10.25375	7
54	9.74644	9.91908	9.82735	10.17265	10.08092	10.25356	6
55	9.74662	9.91900	9.82762	10.17238	10.08100	10.25338	5
56	9.74681	9.91892	9.82790	10.17210	10.08109	10.25319	4
57	9.74700	9.91883	9.82817	10.17183	10.08117	10.25300	3
58	9.74719	9.91874	9.82844	10.17156	10.08126	10.25281	2
59	9.74737	9.91866	9.82872	10.17129	10.08134	10.25263	1
60	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	0
	~~Sine.~~	Sine		Tang.		Secant.	Min.

56 *Degrees.*

A Table of Artificial Sines,

34 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	60
1	9.74775	9.91849	9.82926	10.17074	10.08151	10.25225	59
2	9.74794	9.91840	9.82953	10.17047	10.08160	10.25206	58
3	9.74812	9.91832	9.82981	10.17020	10.08168	10.25188	57
4	9.74831	9.91823	9.83008	10.16992	10.08177	10.25169	56
5	9.74850	9.91815	9.83035	10.16965	10.08185	10.25150	55
6	9.74868	9.91806	9.83062	10.16938	10.08194	10.25132	54
7	9.74887	9.91798	9.83089	10.16911	10.08202	10.25113	53
8	9.74906	9.91789	9.83117	10.16884	10.08211	10.25094	52
9	9.74924	9.91781	9.83144	10.16856	10.08220	10.25076	51
10	9.74943	9.91772	9.83171	10.16829	10.08228	10.25057	50
11	9.74962	9.91763	9.83198	10.16802	10.08237	10.25039	49
12	9.74980	9.91755	9.83225	10.16775	10.08245	10.25020	48
13	9.74999	9.91746	9.83253	10.16748	10.08254	10.25001	47
14	9.75017	9.91738	9.83280	10.16720	10.08262	10.24983	46
15	9.75036	9.91729	9.83307	10.16693	10.08271	10.24964	45
16	9.75054	9.91720	9.83334	10.16666	10.08280	10.24946	44
17	9.75073	9.91712	9.83361	10.16639	10.08288	10.24927	43
18	9.75091	9.91703	9.83388	10.16612	10.08297	10.24909	42
19	9.75110	9.91695	9.83415	10.16585	10.08305	10.24890	41
20	9.75128	9.91686	9.83443	10.16558	10.08314	10.24872	40
21	9.75147	9.91677	9.83470	10.16530	10.08322	10.24853	39
22	9.75165	9.91669	9.83497	10.16503	10.08331	10.24835	38
23	9.75184	9.91660	9.83524	10.16476	10.08340	10.24816	37
24	9.75202	9.91651	9.83551	10.16449	10.08349	10.24798	36
25	9.75221	9.91643	9.83578	10.16422	10.08357	10.24779	35
26	9.75239	9.91634	9.83605	10.16395	10.08366	10.24761	34
27	9.75258	9.91625	9.83632	10.16368	10.08375	10.24742	33
28	9.75276	9.91617	9.83659	10.16341	10.08383	10.24724	32
29	9.75294	9.91608	9.83686	10.16314	10.08392	10.24706	31
30	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
		Sine.		Tang.		Secant.	Min.

55 *Degrees.*

Tangents, and Secants.

34 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.75313	9.91599	9.83713	10.16287	10.08401	10.24687	30
31	9.75331	9.91591	9.83741	10.16260	10.08409	10.24669	29
32	9.75350	9.91582	9.83768	10.16232	10.08418	10.24651	28
33	9.75368	9.91573	9.83795	10.16205	10.08427	10.24632	27
34	9.75386	9.91565	9.83822	10.16178	10.08435	10.24614	26
35	9.75405	9.91556	9.83849	10.16151	10.08444	10.24595	25
36	9.75423	9.91547	9.83876	10.16124	10.08453	10.24577	24
37	9.75441	9.91539	9.83903	10.16097	10.08462	10.24559	23
38	9.75460	9.91530	9.83930	10.16070	10.08470	10.24541	22
39	9.75478	9.91521	9.83957	10.16043	10.08479	10.24522	21
40	9.75496	9.91512	9.83984	10.16016	10.08488	10.24504	20
41	9.75514	9.91504	9.84011	10.15989	10.08497	10.24486	19
42	9.75533	9.91495	9.84038	10.15962	10.08505	10.24467	18
43	9.75551	9.91486	9.84065	10.15935	10.08514	10.24449	17
44	9.75569	9.91477	9.84092	10.15908	10.08523	10.24431	16
45	9.75587	9.91469	9.84119	10.15881	10.08532	10.24413	15
46	9.75605	9.91460	9.84146	10.15854	10.08540	10.24394	14
47	9.75624	9.91451	9.84173	10.15827	10.08549	10.24376	13
48	9.75642	9.91442	9.84200	10.15800	10.08558	10.24358	12
49	9.75660	9.91433	9.84227	10.15773	10.08567	10.24340	11
50	9.75678	9.91425	9.84254	10.15747	10.08575	10.24322	10
51	9.75696	9.91416	9.84281	10.15720	10.08584	10.24304	9
52	9.75714	9.91407	9.84307	10.15693	10.08593	10.24286	8
53	9.75733	9.91398	9.84334	10.15666	10.08602	10.24267	7
54	9.75751	9.91389	9.84361	10.15639	10.08611	10.24249	6
55	9.75769	9.91381	9.84388	10.15612	10.08619	10.24231	5
56	9.75787	9.91372	9.84415	10.15585	10.08628	10.24213	4
57	9.75805	9.91363	9.84442	10.15558	10.08637	10.24195	3
58	9.75823	9.91354	9.84469	10.15531	10.08646	10.24177	2
59	9.75841	9.91345	9.84496	10.15504	10.08655	10.24159	1
60	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	0
		Sine.		Tang.		Secant.	Min.

55 *Degrees.*

A Table of Artificial Sines,

35 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	60
1	9.75877	9.91328	9.84550	10.15450	10.08672	10.24123	59
2	9.75895	9.91319	9.84576	10.15424	10.08681	10.24105	58
3	9.75913	9.91310	9.84603	10.15397	10.08690	10.24087	57
4	9.75931	9.91301	9.84630	10.15370	10.08699	10.24069	56
5	9.75949	9.91292	9.84657	10.15343	10.08708	10.24051	55
6	9.75967	9.91283	9.84684	10.15316	10.08717	10.24033	54
7	9.75985	9.91274	9.84711	10.15289	10.08726	10.24015	53
8	9.76003	9.91266	9.84738	10.15262	10.08735	10.23997	52
9	9.76021	9.91257	9.84764	10.15236	10.08743	10.23979	51
10	9.76039	9.91248	9.84791	10.15209	10.08752	10.23961	50
11	9.76057	9.91239	9.84818	10.15182	10.08761	10.23943	49
12	9.76075	9.91230	9.84845	10.15155	10.08770	10.23925	48
13	9.76093	9.91221	9.84872	10.15128	10.08779	10.23907	47
14	9.76111	9.91212	9.84899	10.15101	10.08788	10.23889	46
15	9.76129	9.91203	9.84925	10.15075	10.08797	10.23872	45
16	9.76146	9.91194	9.84952	10.15048	10.08806	10.23854	44
17	9.76164	9.91185	9.84979	10.15021	10.08815	10.23836	43
18	9.76182	9.91176	9.85006	10.14994	10.08824	10.23818	42
19	9.76200	9.91167	9.85033	10.14968	10.08833	10.23800	41
20	9.76218	9.91158	9.85059	10.14941	10.08842	10.23782	40
21	9.76236	9.91150	9.85086	10.14914	10.08851	10.23764	39
22	9.76253	9.91141	9.85113	10.14887	10.08860	10.23747	38
23	9.76271	9.91132	9.85140	10.14860	10.08868	10.23729	37
24	9.76289	9.91123	9.85166	10.14834	10.08877	10.23711	36
25	9.76307	9.91114	9.85193	10.14807	10.08886	10.23693	35
26	9.76325	9.91105	9.85220	10.14780	10.08895	10.23676	34
27	9.76342	9.91096	9.85247	10.14753	10.08904	10.23658	33
28	9.76360	9.91087	9.85273	10.14727	10.08913	10.23640	32
29	9.76378	9.91078	9.85300	0.14700	10.08922	10.23622	31
30	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
		Sine.		Tang.		Secant.	Min.

54 *Degrees.*

Tangents, and Secants.

35 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.76395	9.91069	9.85327	10.14673	10.08931	10.23605	30
31	9.76413	9.91060	9.85354	10.14647	10.08940	10.23587	29
32	9.76431	9.91051	9.85380	10.14620	10.08949	10.2356	28
33	9.76449	9.91042	9.85407	10.14593	10.08959	10.23552	27
34	9.76466	9.91033	9.85434	10.14566	10.08968	10.23534	26
35	9.76484	9.91024	9.85460	10.14540	10.08977	10.23516	25
36	9.76502	9.91014	9.85487	10.14513	10.08986	10.23498	24
37	9.76519	9.91005	9.85514	10.14486	10.08995	10.23481	23
38	9.76537	9.90996	9.85540	10.14460	10.09004	10.23463	22
39	9.76554	9.90987	9.85567	10.14433	10.09013	10.23446	21
40	9.76572	9.90978	9.85594	10.14406	10.09022	10.23428	20
41	9.76590	9.90969	9.85620	10.14380	10.09031	10.23410	19
42	9.76607	9.90960	9.85647	10.14353	10.09040	10.23393	18
43	9.76625	9.90951	9.85674	10.14326	10.09049	10.23375	17
44	9.76642	9.90942	9.85700	10.14300	10.09058	10.23358	16
45	9.76660	9.90933	9.85727	10.14273	10.09067	10.23340	15
46	9.76677	9.90924	9.85754	10.14246	10.09076	10.23323	14
47	9.76695	9.90915	9.85780	10.14220	10.09085	10.23305	13
48	9.76712	9.90906	9.85807	10.14193	10.09095	10.23288	12
49	9.76730	9.90896	9.85834	10.14166	10.09104	10.23270	11
50	9.76747	9.90887	9.85860	10.14140	10.09113	10.23253	10
51	9.76765	9.90878	9.85887	10.14113	10.09122	10.23235	9
52	9.76782	9.90869	9.85913	10.14087	10.09131	10.23218	8
53	9.76800	9.90860	9.85940	10.14060	10.09140	10.23200	7
54	9.76817	9.90851	9.85967	10.14033	10.09149	10.23183	6
55	9.76835	9.90842	9.85993	10.14007	10.09158	10.23165	5
56	9.76852	9.90832	9.86020	10.13980	10.09168	10.23148	4
57	9.76870	9.90823	9.86046	10.13954	10.09177	10.23130	3
58	9.76887	9.90814	9.86073	10.13927	10.09186	10.23113	2
59	9.76904	9.90805	0.86100	10.13901	10.09195	10.23096	1
60	9.76922	9.90796	9.86126	10.13974	10.09204	10.23078	0
		Sine.		Tang.		Secant.	Min.

54 *Degrees.*

A Table of Artificial Sines,

36 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
1	9.76939	9.90787	9.86153	10.13847	10.09213	10.23061	59
2	9.76957	9.90777	9.86179	10.13821	10.09223	10.23043	58
3	9.76974	9.90768	9.86206	10.13704	10.09232	10.23026	57
4	9.76991	9.90759	9.86232	10.13768	10.09241	10.23009	56
5	9.77009	9.90750	9.86259	10.13741	10.09250	10.22991	55
6	9.77026	9.90741	9.86285	10.13715	10.09259	10.22974	54
7	9.77043	9.90731	9.86312	10.13688	10.09269	10.22957	53
8	9.77061	9.90722	9.86339	10.13662	10.09278	10.22939	52
9	9.77078	9.90713	9.86365	10.13635	10.09287	10.22922	51
10	9.77095	9.90704	9.86392	10.13609	10.09296	10.22905	50
11	9.77113	9.90695	9.86418	10.13582	10.09306	10.22888	49
12	9.77130	9.90685	9.86445	10.13556	10.09315	10.22870	48
13	9.77147	9.90676	9.86471	10.13529	10.09324	10.22853	47
14	9.77164	9.90667	9.86498	10.13502	10.09333	10.22836	46
15	9.77182	9.90657	9.86524	10.13476	10.09343	10.22819	45
16	9.77199	9.90648	9.86551	10.13450	10.09352	10.22801	44
17	9.77216	9.90639	9.86577	10.13423	10.09361	10.22784	43
18	9.77233	9.90630	9.86604	10.13397	10.09370	10.22767	42
19	9.77259	9.90620	9.86630	10.13370	10.09380	10.22750	41
20	9.77268	9.90611	9.86656	10.13344	10.09389	10.22733	40
21	9.77285	9.90602	9.86683	10.13317	10.09398	10.22715	39
22	9.77302	9.90593	9.86709	10.13291	10.09408	10.22698	38
23	9.77319	9.90583	9.86736	10.13264	10.09417	10.22681	37
24	9.77336	9.90574	9.86762	10.13238	10.09426	10.22664	36
25	9.77353	9.90565	9.86789	10.13211	10.09436	10.22647	35
26	9.77370	9.90555	9.86815	10.13185	10.09445	10.22630	34
27	9.77388	9.90546	9.86842	10.13158	10.09454	10.22613	33
28	9.77405	9.90537	9.86868	10.13132	10.09463	10.22595	32
29	9.77422	9.90527	9.86895	10.13106	10.09473	10.22578	31
30	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
		Sine.		Tang.		Secant.	Min.

53 *Degrees.*

Tangents, and Secants.

36 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.77439	9.90518	9.86921	10.13079	10.09482	10.22561	30
31	9.77456	9.90509	9.86947	10.13053	10.09491	10.22544	29
32	9.77473	9.90499	9.86974	10.13026	10.09501	10.22527	28
33	9.77490	9.90490	9.87000	10.13000	10.09510	10.22510	27
34	9.77507	9.90480	9.87027	10.12974	10.09520	10.22493	26
35	9.77524	9.90471	9.87053	10.12947	10.09529	10.22476	25
36	9.77541	9.90462	9.87079	10.12921	10.09538	10.22459	24
37	9.77558	9.90452	9.87106	10.12894	10.09548	10.22442	23
38	9.77575	9.90443	9.87132	10.12868	10.09557	10.22425	22
39	9.77592	9.90433	9.87159	10.12842	10.09567	10.22408	21
40	9.77609	9.90424	9.87185	10.12815	10.09576	10.22391	20
41	9.77626	9.90415	9.87211	10.12789	10.09585	10.22374	19
42	9.77643	9.90405	9.87238	10.12762	10.09595	10.22357	18
43	9.77660	9.90396	9.87264	10.12736	10.09604	10.22340	17
44	9.77677	9.90386	9.87290	10.12710	10.09614	10.22323	16
45	9.77694	9.90377	9.87317	10.12683	10.09623	10.22306	15
46	9.77711	9.90368	9.87343	10.12657	10.09632	10.22289	14
47	9.77728	9.90358	9.87369	10.12631	10.09642	10.22272	13
48	9.77744	9.90349	9.87396	10.12604	16.09651	10.22256	12
49	9.77761	9.90339	9.87422	10.12578	10.09661	10.22239	11
50	9.77778	9.90330	9.87448	10.12552	10.09670	10.22222	10
51	9.77795	9.90320	9.87475	10.12525	10.09680	10.22205	9
52	9.77812	9.90311	9.87501	10.12499	10.09689	10.22188	8
53	9.77829	9.90301	9.87527	10.12473	10.09699	10.22171	7
54	9.77846	9.90292	9.87554	10.12446	10.09708	10.22154	6
55	9.77862	9.90282	9.87580	10.12420	10.09718	10.22138	5
56	9.77879	9.90273	9.87606	10.12394	10.09727	10.22121	4
57	9.77896	9.90263	9.87633	10.12367	10.09737	10.22104	3
58	9.77913	9.90254	9.87659	10.12341	10.09746	10.22087	2
59	9.77930	9.90244	9.87685	10.12315	10.09757	10.22070	1
60	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	0
		Sine.		Tang.		Secant.	Min.

53 *Degrees.*

A Table of Artificial Sines,

37 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
1	9.77964	9.90225	9.87738	10.12262	10.09775	10.22037	59
2	9.77980	9.90216	9.87764	10.12236	10.09784	10.22020	58
3	9.77997	9.90206	9.87790	10.12210	10.09794	10.22003	57
4	9.78013	9.90197	9.87817	10.12183	10.09803	10.21987	56
5	9.78030	9.90187	9.87843	10.12157	10.09813	10.21970	55
6	9.78047	9.90178	9.87869	10.12131	10.09822	10.21953	54
7	9.78063	9.90168	9.87895	10.12105	10.09832	10.21937	53
8	9.78080	9.90159	9.87922	10.12078	10.09842	10.21920	52
9	9.78097	9.90149	9.87948	10.12052	10.09851	10.21903	51
10	9.78113	9.90139	9.87974	10.12026	10.09861	10.21887	50
11	9.78130	9.90130	9.88000	10.12000	10.09870	10.21870	49
12	9.78147	9.90120	9.88027	10.11973	10.09880	10.21853	48
13	9.78163	9.90111	9.88053	10.11947	10.09889	10.21837	47
14	9.78180	9.90101	9.88080	10.11921	10.09899	10.21810	46
15	9.78197	9.90091	9.88105	10.11895	10.09909	10.21803	45
16	9.78213	9.90082	9.88131	10.11869	10.09918	10.21787	44
17	9.78230	9.90072	9.88158	10.11842	10.09928	10.21770	43
18	9.78246	9.90063	9.88184	10.11816	10.09937	10.21754	42
19	9.78263	9.90053	9.88210	10.11790	10.09947	10.21737	41
20	9.78280	9.90043	9.88236	10.11764	10.09957	10.21720	40
21	9.78296	9.90034	9.88263	10.11738	10.09966	10.21704	39
22	9.78313	9.90024	9.88289	10.11711	10.09976	10.21687	38
23	9.78329	9.90014	9.88315	10.11685	10.09986	10.21671	37
24	9.78346	9.90005	9.88341	10.11659	10.09995	10.21654	36
25	9.78362	9.89995	9.88367	10.11633	10.10005	10.21638	35
26	9.78379	9.89985	9.88393	10.11607	10.10015	10.21621	34
27	9.78395	9.89976	9.88420	10.11580	10.10024	10.21605	33
28	9.78412	9.89966	9.88446	10.11554	10.10034	10.21588	32
29	9.78428	9.89956	9.88472	10.11528	10.10044	10.21572	31
30	9.78445	9.89947	9.88498	10.11502	10.10053	10.21555	30
		Sine.		Tang.		Secant.	Min.

52 *Degrees.*

Tangents, and Secants.

37 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.78445	9.89947	9.88498	10.11502	10.10053	10.21555	30
31	9.78461	9.89937	9.88524	10.11476	10.10063	10.21539	29
32	9.78478	9.89927	9.88550	10.11450	10.10073	10.21522	28
33	9.78494	9.89918	9.88577	10.11424	10.10082	10.21506	27
34	9.78511	9.89908	9.88603	10.11397	10.10092	10.21490	26
35	9.78527	9.89898	9.88629	10.11371	10.10102	10.21473	25
36	9.78543	9.89888	9.88655	10.11345	10.10112	10.21457	24
37	9.78560	9.89879	9.88681	10.11319	10.10121	10.21440	23
38	9.78576	9.89869	9.88707	10.11293	10.10131	10.21424	22
39	9.78593	9.89859	9.88733	10.11267	10.10141	10.21408	21
40	9.78609	9.89849	9.88759	10.11241	10.10151	10.21391	20
41	9.78625	9.89840	9.88786	10.11215	10.10160	10.21375	19
42	9.78642	9.89830	9.88812	10.11188	10.10170	10.21358	18
43	9.78658	9.89820	9.88838	10.11162	10.10180	10.21342	17
44	9.78674	9.89810	9.88864	10.11136	10.10190	10.21326	16
45	9.78691	9.89801	9.88890	10.11110	10.10199	10.21309	15
46	9.78707	9.89791	9.88916	10.11084	10.10209	10.21293	14
47	9.78723	9.89781	9.88942	10.11058	10.10219	10.21277	13
48	9.78740	9.89771	9.88968	10.11032	10.10229	10.21261	12
49	9.78756	9.89761	9.88994	10.11006	10.10239	10.21244	11
50	9.78772	9.89752	9.89020	10.10980	10.10248	10.21228	10
51	9.78788	9.89742	9.89047	10.10954	10.10258	10.21212	9
52	9.78805	9.89732	9.89073	10.10928	10.10268	10.21196	8
53	9.78821	9.89722	9.89099	10.10901	10.10278	10.21179	7
54	9.78837	9.89712	9.89125	10.10875	10.10288	10.21163	6
55	9.78853	9.89703	9.89151	10.10849	10.10298	10.21147	5
56	9.78869	9.89693	9.89177	10.10823	10.10307	10.21131	4
57	9.78886	9.89683	9.89203	10.10797	10.10317	10.21114	3
58	9.78902	9.89673	9.89229	10.10771	10.10327	10.21098	2
59	9.78918	9.89663	9.89255	10.10745	10.10337	10.21082	1
60	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	0
		Sine.		Tang.		Secant.	Min.

52 *Degrees.*

A Table of Artificial Sines,

38 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	60
1	9.78950	9.89643	9.89307	10.10693	10.10357	10.21050	59
2	9.78967	9.89634	9.89333	10.10667	10.10366	10.21034	58
3	9.78983	9.89624	9.89359	10.10641	10.10376	10.21017	57
4	9.78999	9.89614	9.89385	10.10615	10.10386	10.21001	56
5	9.79015	9.89604	9.89411	10.10589	10.10396	10.20985	55
6	9.79031	9.89594	9.89437	10.10563	10.10406	10.20969	54
7	9.79047	9.89584	9.89463	10.10537	10.10416	10.20953	53
8	9.79063	9.89574	9.89489	10.10511	10.10426	10.20937	52
9	9.79079	9.89564	9.89515	10.10485	10.10436	10.20921	51
10	9.79095	9.89554	9.89541	10.10459	10.10446	10.20905	50
11	9.79112	9.89544	9.89567	10.10433	10.10456	10.20889	49
12	9.79128	9.89534	9.89593	10.10407	10.10466	10.20873	48
13	9.79144	9.89524	9.89619	10.10381	10.10476	10.20856	47
14	9.79160	9.89514	9.89645	10.10355	10.10486	10.20840	46
15	9.79176	9.89504	9.89671	10.10329	10.10496	10.20824	45
16	9.79192	9.89494	9.89697	10.10303	10.10506	10.20808	44
17	9.79208	9.89485	9.89723	10.10277	10.10515	10.20792	43
18	9.79224	9.89475	9.89749	10.10251	10.10525	10.20776	42
19	9.79240	9.89465	9.89775	10.10225	10.10535	10.20760	41
20	9.79256	9.89155	9.89801	10.10199	10.10545	10.20744	40
21	9.79272	9.89445	9.89827	10.10173	10.10555	10.20728	39
22	9.79288	9.89435	9.89853	10.10147	10.10565	10.20712	38
23	9.79304	9.89425	9.89879	10.10121	10.10575	10.20696	37
24	9.79320	9.89415	9.89905	10.10095	10.10585	10.20680	36
25	9.79335	9.89405	9.89931	10.10069	10.10595	10.20665	35
26	9.79351	9.89395	9.89957	10.10043	10.10605	10.20649	34
27	9.79367	9.89385	9.89983	10.10017	10.10615	10.20633	33
28	9.79383	9.89374	9.90009	10.09991	10.10626	10.20617	32
29	9.79399	9.89364	9.90035	10.09965	10.10636	10.20601	31
30	9.79415	9.89354	9.90061	10.09940	10.10646	10.20585	30
		Sine.		Tang.		Secant.	Min.

51 *Degrees.*

Tangents, and Secants.

38 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.79415	9.89354	9.90061	10.09940	10.10646	10.20585	30
31	9.79431	9.89344	9.90086	10.09914	10.10656	10.20569	29
32	9.79447	9.89334	9.90112	10.09888	10.10666	10.20553	28
33	9.79463	9.89324	9.90138	10.09862	10.10676	10.20537	27
34	9.79478	9.89314	9.90164	10.09836	10.10686	10.20522	26
35	9.79494	9.89304	9.90190	10.09810	10.10696	10.20506	25
36	9.79510	9.89294	9.90216	10.09784	10.10706	10.20490	24
37	9.79526	9.89284	9.90242	10.09758	10.10716	10.20474	23
38	9.79542	9.89274	9.90268	10.09732	10.10726	10.20458	22
39	9.79558	9.89264	9.90294	10.09706	10.10736	10.20442	21
40	9.79573	9.89254	9.90320	10.09680	10.10746	10.20427	20
41	9.79589	9.89244	9.90346	10.09654	10.10757	10.20411	19
42	9.79605	9.89233	9.90371	10.09629	10.10767	10.20395	18
43	9.79621	9.89223	9.90397	10.09603	10.10777	10.20379	17
44	9.79636	9.89213	9.90423	10.09577	10.10787	10.20364	16
45	9.79652	9.89203	9.90449	10.09551	10.10797	10.20348	15
46	9.79668	9.89193	9.90475	10.09525	10.10807	10.20332	14
47	9.79684	9.89183	9.90501	10.09499	10.10817	10.20316	13
48	9.79699	9.89173	9.90527	10.09473	10.10827	10.20301	12
49	9.79715	9.89162	9.90553	10.09447	10.10838	10.20285	11
50	9.79731	9.89152	9.90578	10.09422	10.10848	10.20269	10
51	9.79746	9.89142	9.90604	10.09396	10.10858	10.20254	9
52	9.79762	9.89132	9.90630	10.09370	10.10868	10.20238	8
53	9.79778	9.89122	9.90656	10.09344	10.10878	10.20222	7
54	9.79793	9.89112	9.90682	10.09318	10.10889	10.20206	6
55	9.79809	9.89101	9.90708	10.09292	10.10899	10.20191	5
56	9.79825	9.89091	9.90734	10.09266	10.10909	10.20175	4
57	9.79840	9.89081	9.90759	10.09241	10.10919	10.20160	3
58	9.79856	9.89071	9.90785	10.09215	10.10929	10.20144	2
59	9.79872	9.89061	9.90811	10.09189	10.10940	10.20128	1
60	9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	0
		Sine.		Tang.		Secant.	Min.

51 *Degrees.*

A Table of Artificial Sines,

39 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	60
1	9.79903	9.89040	9.90863	10.09137	10.10960	10.20097	59
2	9.79918	9.89030	9.90889	10.09111	10.10970	10.20082	58
3	9.79934	9.89020	9.90914	10.09086	10.10981	10.20066	57
4	9.79950	9.89009	9.90940	10.09060	10.10991	10.20051	56
5	9.79965	9.88999	9.90966	10.09034	10.11001	10.20035	55
6	9.79981	9.88989	9.90992	10.09008	10.11011	10.20019	54
7	9.79996	9.88979	9.91018	10.08982	10.11022	10.20004	53
8	9.80012	9.88968	9.91044	10.08957	10.11032	10.19988	52
9	9.80027	9.88958	9.91069	10.08931	10.11042	10.19973	51
10	9.80043	9.88948	9.91095	10.08905	10.11052	10.19957	50
11	9.80058	9.88937	9.91121	10.08879	10.11063	10.19942	49
12	9.80074	9.88927	9.91147	10.08853	10.11073	10.19926	48
13	9.80089	9.88917	9.91172	10.08828	10.11083	10.19911	47
14	9.80105	9.88906	9.91198	10.08802	10.11094	10.19895	46
15	9.80120	9.88896	9.91224	10.08776	10.11104	10.19880	45
16	9.80136	9.88886	9.91250	10.08750	10.11114	10.19864	44
17	9.80151	9.88876	9.91276	10.08724	10.11125	10.19849	43
18	9.80167	9.88865	9.91301	10.08699	10.11135	10.19834	42
19	9.80182	9.88855	9.91327	10.08673	10.11145	10.19818	41
20	9.80197	9.88844	9.91353	10.08647	10.11156	10.19803	40
21	9.80213	9.88834	9.91379	10.08621	10.11166	10.19787	39
22	9.80228	9.88824	9.91404	10.08596	10.11176	10.19772	38
23	9.80244	9.88813	9.91430	10.08570	10.11187	10.19756	37
24	9.80259	9.88803	9.91456	10.08544	10.11197	10.19741	36
25	9.80274	9.88793	9.91482	10.08518	10.11207	10.19726	35
26	9.80290	9.88782	9.91508	10.08493	10.11218	10.19710	34
27	9.80305	9.88772	9.91533	10.08467	10.11228	10.19695	33
28	9.80320	9.88761	9.91559	10.08441	10.11239	10.19680	32
29	9.80336	9.88751	9.91585	10.08415	10.11249	10.19664	31
30	9.80351	9.88741	9.91610	10.08390	10.11259	10.19649	30
		Sine.		Tang.		Secant.	Min.

50 *Degrees.*

Tangents, and Secants.

39 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.80351	9.88741	9.91610	10.08390	10.11259	10.19649	30
31	9.80366	9.88730	9.91636	10.08364	10.11270	10.19634	29
32	9.80382	9.88720	9.91662	10.08338	10.11280	10.19618	28
33	9.80397	9.88709	9.91688	10.08312	10.11291	10.19603	27
34	9.80412	9.88699	9.91713	10.08287	10.11303	10.19588	26
35	9.80428	9.88688	9.91739	10.08261	10.11312	10.19572	25
36	9.80443	9.88678	9.91765	10.08235	10.11322	10.19557	24
37	9.80458	9.88668	9.91791	10.08209	10.11332	10.19542	23
38	9.80473	9.88657	9.91816	10.08184	10.11343	10.19527	22
39	9.80489	9.88647	9.91842	10.08158	10.11353	10.19511	21
40	9.80504	9.88636	9.91868	10.08132	10.11364	10.19496	20
41	9.80519	9.88626	9.91893	10.08107	10.11374	10.19481	19
42	9.80534	9.88615	9.91919	10.08081	10.11385	10.19466	18
43	9.80550	9.88605	9.91945	10.08055	10.11395	10.19451	17
44	9.80565	9.88594	9.91971	10.08029	10.11406	10.19435	16
45	9.80580	9.88584	9.91996	10.08004	10.11416	10.19420	15
46	9.80595	9.88573	9.92022	10.07978	10.11427	10.19405	14
47	9.80610	9.88563	9.92048	10.07952	10.11437	10.19390	13
48	9.80625	9.88552	9.92073	10.07927	10.11448	10.19375	12
49	9.80641	9.88542	9.92099	10.07901	10.11458	10.19359	11
50	9.80656	9.88531	9.92125	10.07875	10.11469	10.19344	10
51	9.80671	9.88520	9.92150	10.07850	10.11479	10.19329	9
52	9.80686	9.88510	9.92176	10.07824	10.11490	10.19314	8
53	9.80701	9.88499	9.92202	10.07798	10.11501	10.19299	7
54	9.80716	9.88489	9.92227	10.07773	10.11511	10.19284	6
55	9.80731	9.88478	9.92253	10.07747	10.11522	10.19269	5
56	9.80746	9.88468	9.92279	10.07721	10.11532	10.19254	4
57	9.80762	9.88457	9.92304	10.07696	10.11543	10.19239	3
58	9.80777	9.88447	9.92330	10.07670	10.11553	10.19223	2
59	9.80792	9.88436	9.92356	10.07644	10.11564	10.19208	1
60	9.80[illegible]07	9.88425	9.92381	10.07619	10.11575	10.19193	0
		Sine.		Tang.		Secant.	Min.

8

50 *Degrees.*

A Table of Artificial Sines,

40 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	60
1	9.80822	9.88415	9.92407	10.07593	10.11585	10.19178	59
2	9.80837	9.88404	9.92433	10.07567	10.11596	10.19163	58
3	9.80852	9.88394	9.92458	10.07542	10.11606	10.19148	57
4	9.80867	9.88383	9.92484	10.07516	10.11617	10.19133	56
5	9.80882	9.88372	9.92510	10.07490	10.11628	10.19118	55
6	9.80897	9.88362	9.92535	10.07465	10.11638	10.19103	54
7	9.80912	9.88351	9.92561	10.07439	10.11649	10.19088	53
8	9.80927	9.88340	9.92587	10.07414	10.11660	10.19073	52
9	9.80942	9.88330	9.92612	10.07388	10.11670	10.19058	51
10	9.80957	9.88319	9.92638	10.07362	10.11681	10.19043	50
11	9.80972	9.88308	9.92663	10.07337	10.11692	10.19028	49
12	9.80987	9.88298	9.92689	10.07311	10.11702	10.19013	48
13	9.81002	9.88287	9.92715	10.07285	10.11713	10.18998	47
14	9.81017	9.88276	9.92740	10.07260	10.11724	10.18983	46
15	9.81032	9.88266	9.92766	10.07234	10.11734	10.18968	45
16	9.81047	9.88255	9.92792	10.07209	10.11745	10.18953	44
17	9.81061	9.88244	9.92817	10.07183	10.11756	10.18939	43
18	9.81076	9.88234	9.92843	10.07157	10.11766	10.18924	42
19	9.81091	9.88223	9.92868	10.07132	10.11777	10.18909	41
20	9.81106	9.88212	9.92894	10.07106	10.11788	10.18894	40
21	9.81121	9.88201	9.92920	10.07080	10.11799	10.18879	39
22	9.81136	9.88191	9.92945	10.07055	10.11809	10.18864	38
23	9.81151	9.88180	9.92971	10.07029	10.11820	10.18849	37
24	9.81166	9.88169	9.92996	10.07004	10.11831	10.18834	36
25	9.81180	9.88158	9.93022	10.06978	10.11842	10.18820	35
26	9.81195	9.88148	9.93048	10.06952	10.11852	10.18805	34
27	9.81210	9.88137	9.93073	10.06927	10.11863	10.18790	33
28	9.81225	9.88126	9.93099	10.06901	10.11874	10.18775	32
29	9.81240	9.88115	9.93124	10.06876	10.11885	10.18760	31
30	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	30
		Sine.		Tang.		Secant.	Min.

49 *Degrees.*

Tangents, and Secants.

40 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.81254	9.88105	9.93150	10.06850	10.11895	10.18746	30
31	9.81269	9.88094	9.93176	10.06824	10.11906	10.18731	29
32	9.81284	9.88083	9.93201	10.06799	10.11917	10.18716	28
33	9.81299	9.88072	9.93227	10.06773	10.11928	10.18701	27
34	9.81314	9.88061	9.93252	10.06748	10.11939	10.18686	26
35	9.81328	9.88050	9.93278	10.06722	10.11950	10.18672	25
36	9.81343	9.88040	9.93303	10.06697	10.11960	10.18657	24
37	9.81358	9.88029	9.93329	10.06671	10.11971	10.18642	23
38	9.81372	9.88018	9.93355	10.06646	10.11982	10.18628	22
39	9.81387	9.88007	9.93380	10.06620	10.11993	10.18613	21
40	9.81402	9.87996	9.93406	10.06594	10.12004	10.18598	20
41	9.81417	9.87986	9.93431	10.06569	10.12014	10.18583	19
42	9.81431	9.87975	9.93457	10.06543	10.12025	10.18569	18
43	9.81446	9.87964	9.93482	10.06518	10.12036	10.18554	17
44	9.81461	9.87953	9.93508	10.06492	10.12047	10.18539	16
45	9.81475	9.87942	9.93533	10.06467	10.12058	10.18525	15
46	9.81490	9.87931	9.93559	10.06441	10.12069	10.18510	14
47	9.81505	9.87920	9.93584	10.06416	10.12080	10.18495	13
48	9.81519	9.87909	9.93610	10.06390	10.12091	10.18481	12
49	9.81534	9.87898	9.93635	10.06365	10.12102	10.18466	11
50	9.81549	9.87888	9.93661	10.06339	10.12112	10.18451	10
51	9.81563	9.87877	9.93687	10.06313	10.12123	10.18437	9
52	9.81578	9.87866	9.93712	10.06288	10.12134	10.18422	8
53	9.81592	9.87855	9.93738	10.06262	10.12145	10.18408	7
54	9.81607	9.87844	9.93763	10.06237	10.12156	10.18393	6
55	9.81621	9.87833	9.93789	10.06211	10.12167	10.18379	5
56	9.81636	9.87822	9.93814	10.06186	10.12178	10.18364	4
57	9.81651	9.87811	9.93840	10.06160	10.12189	10.18349	3
58	9.81665	9.87800	9.93865	10.06135	10.12200	10.18335	2
59	9.81680	9.87789	9.93891	10.06109	10.12211	10.18320	1
60	9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	0
		Sine.		Tang.		Secant.	Min.

49 *Degrees.*

A Table of Artificial Sines,

41 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	60
1	9.81709	9.87767	9.93942	10.06058	10.12233	10.18291	59
2	9.81723	9.87756	9.93967	10.06033	10.12244	10.18277	58
3	9.81738	9.87745	9.93993	10.06007	10.12255	10.18262	57
4	9.81752	9.87734	9.94018	10.05982	10.12266	10.18248	56
5	9.81767	9.87723	9.94044	10.05956	10.12277	10.18233	55
6	9.81781	9.87712	9.94069	10.05931	10.12288	10.18219	54
7	9.81796	9.87701	9.94095	10.05905	10.12299	10.18204	53
8	9.81810	9.87690	9.94120	10.05880	10.12310	10.18190	52
9	9.81825	9.87679	9.94146	10.05854	10.12321	10.18175	51
10	9.81839	9.87668	9.94171	10.05829	10.12332	10.18161	50
11	9.81854	9.87657	9.94197	10.05803	10.12343	10.18146	49
12	9.81868	9.87646	9.94222	10.05778	10.12354	10.18132	48
13	9.81883	9.87635	9.94248	10.05752	10.12365	10.18117	47
14	9.81897	9.87624	9.94273	10.05727	10.12376	10.18103	46
15	9.81911	9.87613	9.94299	10.05701	10.12388	10.18089	45
16	9.81926	9.87601	9.94324	10.05676	10.12399	10.18074	44
17	9.81940	9.87590	9.94350	10.05650	10.12410	10.18060	43
18	9.81955	9.87579	9.94375	10.05625	10.12421	10.18045	42
19	9.81969	9.87568	9.94401	10.05599	10.12432	10.18031	41
20	9.81983	9.87557	9.94426	10.05574	10.12443	10.18017	40
21	9.81998	9.87546	9.94452	10.05548	10.12454	10.18002	39
22	9.82012	9.87535	9.94477	10.05523	10.12465	10.17988	38
23	9.82026	9.87524	9.94503	10.05497	10.12476	10.17974	37
24	9.82041	9.87513	9.94528	10.05472	10.12487	10.17959	36
25	9.82055	9.87501	9.94554	10.05446	10.12499	10.17945	35
26	9.82069	9.87490	9.94579	10.05421	10.12510	10.17931	34
27	9.82084	9.87479	9.94605	10.05396	10.12521	10.17916	33
28	9.82098	9.87468	9.94630	10.05370	10.12532	10.17902	32
29	9.82112	9.87457	9.94655	10.05345	10.12543	10.17888	31
30	9.82127	9.87446	9.94681	10.05319	10.12554	10.17873	30
		Sine.		Tang.		Secant.	Min.

48 *Degrees.*

Tangents, and Secants.

41 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.82127	9.87446	9.94681	10.05319	10.12554	10.17874	30
31	9.82141	9.87434	9.94706	10.05294	10.12566	10.17859	29
32	9.82155	9.87423	9.94732	10.05268	10.12577	10.17845	28
33	9.82169	9.87412	9.94757	10.05243	10.12588	10.17831	27
34	9.82184	9.87401	9.94783	10.05217	10.12599	10.17817	26
35	9.82198	9.87390	9.94808	10.05192	10.12610	10.17802	25
36	9.82212	9.87378	9.94834	10.05166	10.12622	10.17788	24
37	9.82226	9.87367	9.94859	10.05141	10.12633	10.17774	23
38	9.82240	9.87356	9.94884	10.05116	10.12644	10.17760	22
39	9.82255	9.87345	9.94910	10.05090	10.12655	10.17745	21
40	9.82269	9.87334	9.94935	10.05065	10.12667	10.17731	20
41	9.82283	9.87322	9.94961	10.05039	10.12678	10.17717	19
42	9.82297	9.87311	9.94986	10.05014	10.12689	10.17703	18
43	9.82311	9.87300	9.95012	10.04988	10.12700	10.17689	17
44	9.82326	9.87289	9.95037	10.04963	10.12712	10.17674	16
45	9.82340	9.87277	9.95063	10.04938	10.12723	10.17660	15
46	9.82354	9.87266	9.95088	10.04912	10.12734	10.17646	14
47	9.82368	9.87255	9.95113	10.04887	10.12745	10.17632	13
48	9.82382	9.87243	9.95139	10.04861	10.12757	10.17618	12
49	9.82396	9.87232	9.95164	10.04836	10.12768	10.17604	11
50	9.82410	9.87221	9.95190	10.04810	10.12779	10.17590	10
51	9.82425	9.87209	9.95215	10.04785	10.12791	10.17575	9
52	9.82439	9.87198	9.95240	10.04760	10.12802	10.17561	8
53	9.82453	9.87187	9.95266	10.04734	10.12813	10.17547	7
54	9.82467	9.87176	9.95291	10.04709	10.12825	10.17533	6
55	9.82481	9.87164	9.95317	10.04683	10.12836	10.17519	5
56	9.82495	9.87153	9.95342	10.04658	10.12847	10.17505	4
57	9.82509	9.87141	9.95368	10.04633	10.12859	10.17491	3
58	9.82523	9.87130	9.95393	10.04607	10.12870	10.17477	2
59	9.82537	9.87119	9.95418	10.04582	10.12881	10.17463	1
60	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449	0
		Sine.		Tang.		Secant.	Min.

48 *Degrees.*

A Table of Artificial Sines,

42 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449	60
1	9.82565	9.87096	9.95469	10.04531	10.12904	10.17435	59
2	9.82579	9.87085	9.95495	10.04505	10.12915	10.17421	58
3	9.82593	9.87073	9.95520	10.04480	10.12927	10.17407	57
4	9.82607	9.87062	9.95545	10.04455	10.12938	10.17393	56
5	9.82621	9.87050	9.95571	10.04429	10.12950	10.17379	55
6	9.82635	9.87039	9.95596	10.04404	10.12961	10.17365	54
7	9.82649	9.87028	9.95622	10.04378	10.12972	10.17351	53
8	9.82663	9.87016	9.95647	10.04353	10.12984	10.17337	52
9	9.82677	9.87005	9.95672	10.04328	10.12995	10.17323	51
10	9.82691	9.86993	9.95698	10.04302	10.13007	10.17309	50
11	9.82705	9.86982	9.95723	10.04277	10.13018	10.17295	49
12	9.82719	9.86970	9.95749	10.04252	10.13030	10.17281	48
13	9.82733	9.86959	9.95774	10.04226	10.13041	10.17267	47
14	9.82747	9.86947	9.95799	10.04201	10.13053	10.17253	46
15	9.82761	9.86936	9.95825	10.04175	10.13064	10.17239	45
16	9.82774	9.86925	9.95850	10.04150	10.13075	10.17226	44
17	9.82788	9.86913	9.95875	10.04125	10.13087	10.17212	43
18	9.82802	9.86901	9.95901	10.04099	10.13099	10.17198	42
19	9.82816	9.86890	9.95926	10.04074	10.13110	10.17184	41
20	9.82830	9.86879	9.95952	10.04048	10.13121	10.17170	40
21	9.82844	9.86867	9.95977	10.04023	10.13133	10.17156	39
22	9.82858	9.86856	9.96002	10.03998	10.13144	10.17142	38
23	9.82872	9.86844	9.96028	10.03972	10.13156	10.17128	37
24	9.82886	9.86832	9.96053	10.03947	10.13168	10.17114	36
25	9.82899	9.86821	9.96078	10.03922	10.13179	10.17101	35
26	9.82913	9.86809	9.96104	10.03896	10.13191	10.17087	34
27	9.82927	9.86798	9.96129	10.03871	10.13202	10.17073	33
28	9.82941	9.86786	9.96155	10.03846	10.13214	10.17059	32
29	9.82954	9.86775	9.96180	10.03820	10.13225	10.17046	31
30	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
		Sine.		Tang.		Secant.	Min.

47 *Degrees.*

Tangents, and Secants.

42 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.82968	9.86763	9.96205	10.03795	10.13237	10.17032	30
31	9.82982	9.86752	9.96231	10.03769	10.13248	10.17018	29
32	9.82996	9.86740	9.96256	10.03744	10.13260	10.17004	28
33	9.83010	9.86728	9.96281	10.03719	10.13272	10.16990	27
34	9.83023	9.86717	9.96307	10.03693	10.13283	10.16977	26
35	9.83037	9.86705	9.96332	10.03668	10.13295	10.16963	25
36	9.83051	9.86694	9.96357	10.03643	10.13306	10.16949	24
37	9.83065	9.86682	9.96383	10.03617	10.13318	10.16935	23
38	9.83078	9.86670	9.96408	10.03592	10.13330	10.16922	22
39	9.83092	9.86659	9.96434	10.03566	10.13341	10.16908	21
40	9.83106	9.86647	9.96459	10.03541	10.13353	10.16894	20
41	9.83120	9.86635	9.96484	10.03516	10.13365	10.16880	19
42	9.83133	9.86624	9.96510	10.03490	10.13376	10.16867	18
43	9.83147	9.86612	9.96535	10.03465	10.13388	10.16853	17
44	9.83161	9.86600	9.96560	10.03440	10.13400	10.16839	16
45	9.83174	9.86589	9.96586	10.03414	10.13411	10.16826	15
46	9.83188	9.86577	9.96611	10.03389	10.13423	10.16812	14
47	9.83202	9.86565	9.96636	10.03364	10.13435	10.16798	13
48	9.83215	9.86554	9.96662	10.03338	10.13446	10.16785	12
49	9.83229	9.86542	9.96687	10.03313	10.13458	10.16771	11
50	9.83243	9.86530	9.96712	10.03288	10.13470	10.16757	10
51	9.83256	9.86519	9.96738	10.03262	10.13481	10.16744	9
52	9.83270	9.86507	9.96763	10.03237	10.13493	10.16730	8
53	9.83283	9.86495	9.96788	10.03212	10.13505	10.16717	7
54	9.83297	9.86483	9.96814	10.03186	10.13517	10.16703	6
55	9.83311	9.86472	9.96839	10.03161	10.13528	10.16689	5
56	9.83324	9.86460	9.96864	10.03136	10.13540	10.16676	4
57	9.83338	9.86448	9.96890	10.03110	10.13552	10.16662	3
58	9.83351	9.86436	9.96915	10.03085	10.13564	10.16649	2
59	9.83365	9.86425	9.96940	10.03060	10.13575	10.16635	1
60	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	0
		Sine.		Tang.		Secant.	Min.

47 *Degrees.*

A Table of Artificial Sines,

43 *Degrees.*

Min.	Sine.		Tang.		Secant.		
0	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622	60
1	9.83392	9.86401	9.96991	10.03009	10.13599	10.16608	59
2	9.83405	9.86389	9.97016	10.02984	10.13611	10.16595	58
3	9.83419	9.86377	9.97042	10.02958	10.13623	10.16581	57
4	9.83433	9.86366	9.97067	10.02933	10.13634	10.16567	56
5	9.83446	9.86354	9.97092	10.02908	10.13646	10.16554	55
6	9.83460	9.86342	9.97118	10.02882	10.13658	10.16540	54
7	9.83473	9.86330	9.97143	10.02857	10.13670	10.16527	53
8	9.83487	9.86318	9.97168	10.02832	10.13682	10.16513	52
9	9.83500	9.86306	9.97194	10.02806	10.13694	10.16500	51
10	9.83513	9.86295	9.97219	10.02781	10.13705	10.16487	50
11	9.83527	9.86283	9.97244	10.02756	10.13717	10.16473	49
12	9.83540	9.86271	9.97269	10.02731	10.13729	10.16460	48
13	9.83554	9.86259	9.97295	10.02705	10.13741	10.16446	47
14	9.83567	9.86247	9.97320	10.02680	10.13753	10.16433	46
15	9.83581	9.86235	9.97345	10.02655	10.13765	10.16419	45
16	9.83594	9.86223	9.97371	10.02629	10.13777	10.16406	44
17	9.83608	9.86212	9.97396	10.02604	10.13788	10.16392	43
18	9.83621	9.86200	9.97421	10.02579	10.13800	10.16379	42
19	9.83634	9.86188	9.97447	10.02553	10.13812	10.16366	41
20	9.83648	9.86176	9.97472	10.02528	10.13824	10.16352	40
21	9.83661	9.86164	9.97497	10.02503	10.13836	10.16339	39
22	9.83675	9.86152	9.97523	10.02477	10.13848	10.16325	38
23	9.83688	9.86140	9.97548	10.02452	10.13860	10.16312	37
24	9.83701	9.86128	9.97573	10.02427	10.13872	10.16299	36
25	9.83715	9.86116	9.97599	10.02401	10.13884	10.16285	35
26	9.83728	9.86104	9.97624	10.02376	10.13896	10.16272	34
27	9.83741	9.86092	9.97649	10.02351	10.13908	10.16259	33
28	9.83755	9.86080	9.97674	10.02326	10.13920	10.16245	32
29	9.83768	9.86068	9.97700	10.02300	10.13932	10.16232	31
30	9.83781	9.86056	9.97725	10.02375	10.13944	10.16219	30
		Sine.		Tang.		Secant.	Min.

46 *Degrees.*

Tangents, and Secants.

43 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.83781	9.86056	9.97725	10.02275	10.13944	10.16219	30
31	9.83794	9.86044	9.97750	10.02250	10.13956	10.16206	29
32	9.83808	9.86032	9.97776	10.02224	10.13968	10.16192	28
33	9.83821	9.86020	9.97801	10.02199	10.13980	10.16179	27
34	9.83834	9.86008	9.97826	10.02174	10.13992	10.16166	26
35	9.83848	9.85996	9.97852	10.02149	10.14004	10.16152	25
36	9.83861	9.85984	9.97877	10.02123	10.14016	10.16139	24
37	9.83874	9.85972	9.97902	10.02098	10.14028	10.16126	23
38	9.83887	9.85960	9.97927	10.02073	10.14040	10.16113	22
39	9.83901	9.85948	9.97953	10.02047	10.14052	10.16099	21
40	9.83914	9.85936	9.97978	10.02022	10.14064	10.16086	20
41	9.83927	9.85924	9.98003	10.01997	10.14076	10.16073	19
42	9.83940	9.85912	9.98029	10.01971	10.14088	10.16060	18
43	9.83954	9.85900	9.98054	10.01946	10.14100	10.16046	17
44	9.83967	9.85888	9.98079	10.01921	10.14112	10.16033	16
45	9.83980	9.85876	9.98104	10.01896	10.14124	10.16020	15
46	9.83993	9.85864	9.98130	10.01870	10.14136	10.16007	14
47	9.84006	9.85851	9.98155	10.01845	10.14148	10.15994	13
48	9.84020	9.85839	9.98180	10.01820	10.14160	10.15980	12
49	9.84033	9.85827	9.98206	10.01794	10.14173	10.15967	11
50	9.84046	9.85815	9.98231	10.01769	10.14185	10.15954	10
51	9.84059	9.85803	9.98256	10.01744	10.14197	10.15941	9
52	9.84072	9.85791	9.98281	10.01719	10.14209	10.15928	8
53	9.84085	9.85779	9.98307	10.01693	10.14221	10.15915	7
54	9.84099	9.85767	9.98332	10.01668	10.14234	10.15901	6
55	9.84112	9.85754	9.98367	10.01643	10.14246	10.15888	5
56	9.84125	9.85742	9.98383	10.01617	10.14258	10.15875	4
57	9.84138	9.85730	9.98408	10.01592	10.14270	10.15862	3
58	9.84151	9.85718	9.98433	10.01567	10.14282	10.15849	2
59	9.84164	9.85706	9.98458	10.01542	10.14294	10.15836	1
60	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823	0
		Sine.		Tang.		Secant.	Min.

46 *Degrees.*

A Table of Artificial Sines,

44 *Degrees.*

Min.	Sinc.		Tang.		Secant.		
0	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823	60
1	9.84190	9.85681	9.98509	10.01491	10.14319	10.15810	59
2	9.84203	9.85669	9.98534	10.01466	10.14331	10.15797	58
3	9.84216	9.85657	9.98560	10.01440	10.14343	10.15784	57
4	9.84230	9.85645	9.98585	10.01415	10.14355	10.15770	56
5	9.84242	9.85632	9.98610	10.01390	10.14368	10.15758	55
6	9.84255	9.85620	9.98635	10.01365	10.14380	10.15745	54
7	9.84268	9.85608	9.98661	10.01339	10.14392	10.15732	53
8	9.84282	9.85596	9.98686	10.01314	10.14404	10.15718	52
9	9.84295	9.85583	9.98711	10.01289	10.14417	10.15705	51
10	9.84308	9.85571	9.98736	10.01264	10.14429	10.15692	50
11	9.84321	9.85559	9.98762	10.01238	10.14441	10.15679	49
12	9.84334	9.85547	9.98787	10.01213	10.14453	10.15666	48
13	9.84347	9.85534	9.98812	10.01188	10.14466	10.15653	47
14	9.84360	9.85522	9.98838	10.01162	10.14478	10.15640	46
15	9.84372	9.85510	9.98863	10.01137	10.14490	10.15628	45
16	9.84385	9.85497	9.98888	10.01112	10.14503	10.15615	44
17	9.84398	9.85485	9.98913	10.01087	10.14515	10.15602	43
18	9.84411	9.85473	9.98939	10.01061	10.14527	10.15589	42
19	9.84424	9.85460	9.98964	10.01036	10.14540	10.15576	41
20	9.84437	9.85448	9.98989	10.01011	10.14552	10.15563	40
21	9.84450	9.85436	9.99014	10.00986	10.14564	10.15550	39
22	9.84463	9.85423	9.99040	10.00960	10.14577	10.15537	38
23	9.84476	9.85411	9.99065	10.00935	10.14589	10.15524	37
24	9.84489	9.85399	9.99090	10.00910	10.14601	10.15511	36
25	9.84502	9.85386	9.99116	10.00884	10.14614	10.15498	35
26	9.84515	9.85374	9.99141	10.00859	10.14626	10.15485	34
27	9.84528	9.85361	9.99166	10.00834	10.14639	10.15472	33
28	9.84540	9.85349	9.99191	10.00809	10.14651	10.15460	32
29	9.84553	9.85337	9.99217	10.00783	10.14663	10.15447	31
30	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
		Sine.		Tang.		Secant.	Min.

45 *Degrees.*

Tangents, and Secants.

44 *Degrees.*

Min.	Sine.		Tang.		Secant.		
30	9.84566	9.85324	9.99242	10.00758	10.14676	10.15434	30
31	9.84579	9.85312	9.99267	10.00733	10.14688	10.15421	29
32	9.84592	9.85299	9.99293	10.00708	10.14701	10.15408	28
33	9.84605	9.85287	9.99318	10.00682	10.14713	10.15395	27
34	9.84618	9.85275	9.99343	10.00657	10.14725	10.15382	26
35	9.84630	9.85262	9.99368	10.00632	10.14738	10.15370	25
36	9.84643	9.85250	9.99394	10.00606	10.14750	10.15357	24
37	9.84656	9.85237	9.99419	10.00581	10.14763	10.15344	23
38	9.84669	9.85225	9.99444	10.00556	10.14775	10.15331	22
39	9.84682	9.85212	9.99469	10.00531	10.14788	10.15318	21
40	9.84694	9.85200	9.99495	10.00505	10.14800	10.15306	20
41	9.84707	9.85187	9.99520	10.00480	10.14813	10.15293	19
42	9.84720	9.85175	9.99545	10.00455	10.14825	10.15280	18
43	9.84733	9.85162	9.99571	10.00430	10.14838	10.15267	17
44	9.84745	9.85150	9.99596	10.00404	10.14850	10.15255	16
45	9.84758	9.85137	9.99621	10.00379	10.14863	10.15242	15
46	9.84771	9.85125	9.99646	10.00354	10.14875	10.15229	14
47	9.84784	9.85112	9.99672	10.00329	10.14888	10.15216	13
48	9.84796	9.85100	9.99697	10.00303	10.14900	10.15204	12
49	9.84809	9.85087	9.99722	10.00278	10.14913	10.15191	11
50	9.84822	9.85075	9.99747	10.00253	10.14925	10.15178	10
51	9.84835	9.85062	9.99773	10.00227	10.14938	10.15165	9
52	9.84847	9.85049	9.99798	10.00202	10.14951	10.15153	8
53	9.84860	9.85037	9.99823	10.00177	10.14963	10.15140	7
54	9.84873	9.85924	9.99848	10.00152	10.14976	10.15127	6
55	9.84885	9.85012	9.99874	10.00126	10.14988	10.15115	5
56	9.84898	9.85999	9.99899	10.00101	10.15001	10.15102	4
57	9.84911	9.85986	9.99924	10.00076	10.15014	10.15089	3
58	9.84923	9.85974	9.99950	10.00051	10.15026	10.15077	2
59	9.84936	9.85961	9.99975	10.00025	10.15039	10.15064	1
60	9.84949	9.85949	10.00000	10.00000	10.15051	10.15051	0
		Sine.		Tang.		Secant.	Min.

45 *Degrees.*

A
TABLE
OF THE
SUN's DECLINATION,

From the Year 1770, to the Year 1798; for every Day at Noon, under the Meridian of *London*.

WITH

A TABLE of PROPORTIONAL PARTS, to make it ſerve for any other Meridian.

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S.		Feb. S.		March S.		April N.		May N.		June N.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	22	59	16	58	07	24	04	43	15	12	22	07	1
2	22	53	16	41	07	01	05	06	15	30	22	15	2
3	22	47	16	23	06	38	05	29	15	48	22	23	3
4	22	41	16	05	06	15	05	52	16	05	22	20	4
5	22	35	15	46	05	52	06	14	16	22	22	36	5
6	22	27	15	28	05	29	06	37	16	39	22	43	6
7	22	20	15	09	05	05	06	59	16	56	22	49	7
8	22	12	14	50	04	42	07	22	17	12	22	54	8
9	22	03	14	31	04	19	07	44	17	28	22	59	9
10	21	54	14	11	03	55	08	06	17	44	23	04	10
11	21	45	13	52	03	32	08	28	17	59	23	08	11
12	21	35	13	32	03	08	08	50	18	14	23	12	12
13	21	24	13	11	02	44	09	12	18	29	23	15	13
14	21	14	12	51	02	21	09	34	18	44	23	19	14
15	21	03	12	30	01	57	09	55	18	58	23	21	15
16	20	51	12	10	01	33	10	16	19	12	23	23	16
17	20	39	11	49	01	10	10	37	19	25	23	25	17
18	20	27	11	27	00	46	10	58	19	39	23	27	18
19	20	14	11	06	00	22	11	19	19	52	23	28	19
20	20	01	10	45	N	01	11	40	20	04	23	29	20
21	19	48	10	23	00	25	12	00	20	16	23	29	21
22	19	34	10	01	00	49	12	20	20	28	23	28	22
23	19	20	09	39	01	12	12	40	20	40	23	27	23
24	19	06	09	17	01	36	13	00	20	51	23	26	24
25	18	51	08	55	01	59	13	20	21	02	23	25	25
26	18	36	08	32	02	23	13	39	21	12	23	23	26
27	18	20	08	10	02	46	13	58	21	22	23	21	27
28	18	04	07	47	03	10	14	17	21	32	23	18	28
29	17	48			03	33	14	36	21	42	23	15	29
30	17	32			03	56	14	54	21	51	23	11	30
31	17	15			04	20			21	59			31

1773, 1777, 1781, 1785, 1789, 1793, 1797,
each being the firſt Year after Leap Year.

Days.	July N.		Auguſt N.		Sept. N. *		Oct. S.		Nov. S.		Decem. S.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	23	07	17	58	08	10	03	20	14	36	21	55	1
2	23	03	17	43	07	49	03	44	14	55	22	04	2
3	22	58	17	27	07	27	04	07	15	13	22	12	3
4	22	53	17	11	07	04	04	30	15	32	22	20	4
5	22	48	16	55	06	42	04	53	15	50	22	28	5
6	22	42	16	39	06	20	05	16	16	08	22	35	6
7	22	35	16	22	05	57	05	39	16	26	22	42	7
8	22	28	16	05	05	34	06	02	16	44	22	48	8
9	22	21	15	48	05	12	06	25	17	01	22	54	9
10	22	14	15	30	04	49	06	48	17	18	22	59	10
11	22	06	15	12	04	26	07	11	17	34	23	04	11
12	21	58	14	54	04	03	07	34	17	51	23	09	12
13	21	49	14	36	03	40	07	56	18	07	23	13	13
14	21	40	14	17	03	17	08	18	18	23	23	16	14
15	21	31	13	59	02	54	08	41	18	38	23	20	15
16	21	21	13	40	02	31	09	03	18	53	23	22	16
17	21	11	13	21	02	07	09	25	19	08	23	24	17
18	21	00	13	01	01	44	09	47	19	22	23	26	18
19	20	40	12	42	01	21	10	09	19	36	23	27	19
20	20	38	12	22	00	57	10	30	19	50	23	28	20
21	20	27	12	02	09	34	10	52	20	03	23	29	21
22	20	15	11	42	00	11	11	13	20	16	23	28	22
23	20	02	11	21	S	13	11	34	20	28	23	27	23
24	19	50	11	01	00	36	11	55	20	41	23	26	24
25	19	37	10	40	01	00	12	16	20	52	23	25	25
26	19	24	10	19	01	23	12	36	21	04	23	23	26
27	19	10	09	58	01	47	12	57	21	15	23	20	27
28	18	57	09	37	02	10	13	17	21	25	23	17	28
29	18	43	09	15	02	34	13	37	21	36	23	14	29
30	18	28	08	54	02	57	13	57	21	45	23	10	30
31	18	13	08	32			14	17			23	05	31

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S.		Feb. S.		March S. •		April N.		May N.		June N.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	23	00	17	02	07	30	04	37	15	08	22	05	1
2	22	55	16	45	07	07	05	00	15	26	22	13	2
3	22	49	16	27	06	44	05	23	15	43	22	21	3
4	22	43	16	09	06	21	05	46	16	01	22	28	4
5	22	36	15	51	05	58	06	09	16	18	22	35	5
6	22	29	15	32	05	34	06	31	16	35	22	41	6
7	22	22	15	14	05	11	06	54	16	52	22	47	7
8	22	14	14	55	04	48	07	16	17	08	22	53	8
9	22	05	14	36	04	24	07	39	17	24	22	58	9
10	21	56	14	16	04	01	08	01	17	40	23	01	10
11	21	47	13	56	03	37	08	23	17	56	23	07	11
12	21	37	13	36	03	14	08	45	18	11	23	11	12
13	21	27	13	16	02	50	09	07	18	26	23	15	13
14	21	16	12	56	02	27	09	28	18	40	23	18	14
15	21	05	12	35	02	03	09	50	18	55	23	21	15
16	20	54	12	15	01	39	10	11	19	09	23	23	16
17	20	42	11	54	01	15	10	32	19	22	23	25	17
18	20	30	11	33	00	52	10	53	19	36	23	26	18
19	20	18	11	11	00	28	11	14	19	48	23	27	19
20	20	05	10	50	00	04	11	35	20	01	23	28	20
21	19	51	10	28	N	19	11	55	20	13	23	29	21
22	19	38	10	06	00	43	12	15	20	25	23	29	22
23	19	24	09	44	01	07	12	35	20	37	23	28	23
24	19	09	09	22	01	30	12	55	20	48	23	27	24
25	18	54	09	00	01	54	13	15	20	59	23	25	25
26	18	39	08	37	02	17	13	34	21	10	23	24	26
27	18	24	08	15	02	41	13	53	21	20	23	21	27
28	18	09	07	52	03	04	14	12	21	30	23	19	28
29	17	52			03	27	14	31	21	39	23	16	29
30	17	36			03	51	14	50	21	48	23	12	30
31	17	19			04	14			21	57			31

1770, 1774, 1778, 1782, 1786, 1790, 1794, 1798,
each being the ſecond Year after Leap Year.

Days.	July N.		Auguſt N.		Sept. N. *		Oct. S.		Nov. S.		Decem. S.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	23	08	18	02	08	16	03	15	14	31	21	53	1
2	23	04	17	47	07	54	03	38	14	50	22	02	2
3	22	59	17	31	07	32	04	01	15	09	22	10	3
4	22	54	17	15	07	10	04	24	15	28	22	18	4
5	22	49	16	59	06	47	04	48	15	46	22	26	5
6	22	43	16	43	06	25	05	11	16	04	22	33	6
7	22	37	16	26	06	03	05	34	16	22	22	40	7
8	22	30	16	09	05	40	05	57	16	40	22	47	8
9	22	23	15	52	05	17	06	20	16	57	22	53	9
10	22	16	15	34	04	55	06	43	17	14	22	58	10
11	22	08	15	17	04	32	07	05	17	31	23	03	11
12	22	00	14	59	04	09	07	28	17	47	23	08	12
13	21	51	14	40	03	46	07	51	18	03	23	12	13
14	21	42	14	22	03	23	08	13	18	19	23	16	14
15	21	33	14	03	02	59	08	35	18	34	23	19	15
16	21	23	13	44	02	36	08	58	18	49	23	22	16
17	21	13	13	25	02	13	09	20	19	04	23	24	17
18	21	03	13	06	01	50	09	42	19	19	23	26	18
19	20	52	12	46	01	26	10	03	19	33	23	27	19
20	20	41	12	27	01	03	10	25	19	46	23	28	20
21	20	30	12	07	00	40	10	47	20	00	23	29	21
22	20	18	11	47	00	16	11	08	20	13	23	29	22
23	20	06	11	26	S	07	11	29	20	25	23	28	23
24	19	53	11	06	00	31	11	50	20	38	23	27	24
25	19	40	10	45	00	54	12	11	20	50	23	25	25
26	19	27	10	24	01	18	12	32	21	01	23	23	26
27	19	14	10	03	01	41	12	52	21	12	23	21	27
28	19	00	09	42	02	04	13	12	21	23	23	18	28
29	18	46	09	21	02	27	13	32	21	33	23	15	29
30	18	32	08	59	02	51	13	52	21	43	23	11	30
31	18	17	08	38			14	12			23	05	31

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S.		Feb. S.		March S.		April N.		May N.		June N.		Days.
	°	′	°	′	°	′	°	′	°	′	°	′	
1	23	02	17	07	07	36	04	31	15	03	22	03	1
2	22	56	16	49	07	13	04	54	15	21	22	11	2
3	22	51	16	32	06	50	05	17	15	39	22	19	3
4	22	45	16	14	06	27	05	40	15	56	22	26	4
5	22	38	15	56	06	04	06	03	16	13	22	33	5
6	22	31	15	37	05	41	06	25	16	30	22	39	6
7	22	24	15	19	05	17	06	48	16	47	22	46	7
8	22	16	15	00	04	54	07	10	17	04	22	51	8
9	22	07	14	41	04	31	07	33	17	20	22	57	9
10	21	59	14	21	04	07	07	55	17	36	23	02	10
11	21	49	14	02	03	44	08	17	17	51	23	06	11
12	21	40	13	42	03	20	08	39	18	07	23	10	12
13	21	30	13	21	02	57	09	01	18	22	23	14	13
14	21	19	13	01	02	33	09	23	18	36	23	17	14
15	21	08	12	41	02	09	09	44	18	51	23	20	15
16	20	57	12	20	01	46	10	05	19	05	23	22	16
17	20	46	11	59	01	22	10	27	19	18	23	24	17
18	20	33	11	38	00	58	10	48	19	32	23	26	18
19	20	21	11	17	00	35	11	08	19	45	23	27	19
20	20	08	10	56	00	11	11	29	19	58	23	28	20
21	19	55	10	34	N	13	11	50	20	10	23	29	21
22	19	42	10	12	00	36	12	10	20	22	23	29	22
23	19	27	09	50	01	00	12	30	20	34	23	28	23
24	19	13	09	28	01	24	12	50	20	45	23	27	24
25	18	59	09	06	01	47	13	10	20	56	23	26	25
26	18	43	08	44	02	11	13	29	21	07	23	24	26
27	18	28	08	21	02	34	13	48	21	17	23	22	27
28	18	12	07	59	02	58	14	07	21	27	23	19	28
29	17	56			03	21	14	26	21	37	23	17	29
30	17	40			03	44	14	44	21	46	23	13	30
31	17	23			04	08			21	55			31

1771, 1775, 1779, 1783, 1787, 1791, 1795, 1799,
each being the third after Leap Year.

Days.	July N.		August N.		Sept. N.		Oct. S.		Nov. S.		Dec. S.		Days.
	°	'	°	'	°	'	°	'	°	'	°	'	
1	23	09	18	06	08	22	03	08	14	26	21	50	1
2	23	05	17	51	08	00	03	32	14	45	21	59	2
3	23	01	17	35	07	38	03	55	15	04	22	08	3
4	22	56	17	20	07	16	04	18	15	23	22	16	4
5	22	50	17	04	06	54	04	41	15	41	22	24	5
6	22	45	16	47	06	31	05	05	15	59	22	31	6
7	22	39	16	31	06	09	05	28	16	17	22	38	7
8	22	32	16	14	05	46	05	51	16	35	22	45	8
9	22	25	15	56	05	24	06	14	16	52	22	51	9
10	22	18	15	39	05	01	06	36	17	09	22	57	10
11	22	10	15	21	04	38	06	59	17	26	23	02	11
12	22	02	15	03	04	15	07	21	17	42	23	07	12
13	21	54	14	45	03	52	07	44	17	59	23	12	13
14	21	45	14	27	03	29	08	07	18	14	23	15	14
15	21	36	14	08	03	06	08	29	18	30	23	18	15
16	21	26	13	50	02	43	08	52	18	45	23	21	16
17	21	16	13	30	02	19	09	14	19	00	23	23	17
18	21	06	13	11	01	56	09	36	19	15	23	25	18
19	20	55	12	52	01	33	19	57	19	29	23	27	19
20	20	44	12	32	01	09	10	19	19	43	23	28	20
21	20	33	12	12	00	46	10	41	19	56	23	29	21
22	20	21	11	52	00	23	11	02	20	09	23	29	22
23	20	09	11	32	S	01	11	23	20	22	23	28	23
24	19	57	11	11	00	24	11	44	20	34	23	27	24
25	19	44	10	51	00	48	12	05	20	46	23	26	25
26	19	31	10	30	01	11	12	26	20	58	23	24	26
27	19	18	00	09	01	35	12	46	21	09	23	21	27
28	19	04	09	48	01	58	13	07	21	19	23	19	28
29	18	50	09	26	02	21	13	27	21	30	23	15	29
30	18	36	09	05	02	45	13	47	21	40	23	12	30
31	18	21	08	44			14	06			23	08	31

A TABLE *of the* Sun's *Declination for the Years*

Days.	Jan. S.		Feb. S.		March S. •		April N.		May N.		June N.		Days.
	°	′	°	′	°	′	°	′	°	′	°	′	
1	23	03	17	11	07	19	04	48	15	17	22	09	1
2	22	58	16	53	06	56	05	11	15	34	22	17	2
3	22	52	16	36	06	33	05	34	15	52	22	24	3
4	22	46	16	18	06	10	05	57	16	09	22	31	4
5	22	40	16	00	05	46	06	20	16	26	22	38	5
6	22	33	15	42	05	23	06	42	16	43	22	44	6
7	22	25	15	23	05	00	07	05	17	00	22	50	7
8	22	18	15	05	04	36	07	27	17	16	22	55	8
9	22	10	14	45	04	13	07	50	17	32	23	00	9
10	22	01	14	26	03	49	08	12	17	48	23	05	10
11	21	52	14	07	03	26	08	34	18	03	23	09	11
12	21	42	13	47	03	02	08	56	18	18	23	13	12
13	21	32	13	27	02	39	09	17	18	33	23	16	13
14	21	22	13	06	02	15	09	39	18	47	23	19	44
15	21	11	12	46	01	51	10	00	19	01	23	22	15
16	20	59	12	25	01	28	10	22	19	15	23	24	16
17	20	48	12	05	01	04	10	43	19	29	23	26	17
18	20	36	11	43	00	40	11	03	19	42	23	27	18
19	20	24	11	22	00	17	11	24	19	55	23	28	19
20	20	11	11	01	N	07	11	45	20	07	23	29	20
21	19	58	10	40	00	31	12	05	20	19	23	29	21
22	19	45	10	18	00	54	12	25	20	31	23	28	22
23	19	31	09	56	01	18	12	45	20	43	23	27	23
24	19	17	09	34	01	42	13	05	20	54	23	26	24
25	19	02	09	11	02	05	13	24	21	04	23	24	25
26	18	47	08	49	02	29	13	44	21	15	23	22	26
27	18	32	08	27	02	52	14	03	21	25	23	20	27
28	18	16	08	04	03	15	14	21	21	35	23	17	28
29	18	00	07	41	03	39	14	40	21	44	23	14	29
30	17	44			04	09	14	58	21	53	23	10	30
31	17	28			04	25			22	01			31

1772, 1776, 1780, 1784, 1788, 1792, 1796,
each being Leap Year.

Days.	July		August		Sept.		Oct.		Nov.		Dec.		Days.
	N.		N.		N.		S.		S.		S.		
	°	'	°	'	°	'	°	'	°	'	°	'	
1	23	06	17	55	08	05	03	26	14	40	21	57	1
2	23	02	17	39	08	43	03	49	14	59	22	06	2
3	22	57	17	23	07	21	04	13	15	18	22	14	3
4	22	52	17	07	06	59	04	36	15	37	22	22	4
5	22	46	16	51	06	37	04	59	15	55	22	30	5
6	22	40	16	35	06	14	05	22	16	13	22	37	6
7	22	34	16	18	05	52	05	45	16	30	22	43	7
8	22	27	16	00	05	29	06	08	16	48	22	50	8
9	22	20	15	43	05	06	06	31	17	05	22	55	9
10	22	12	15	26	04	43	06	54	17	22	22	01	10
11	22	04	15	08	04	21	07	16	17	39	23	05	11
12	21	56	14	50	03	58	07	39	17	55	23	10	12
13	21	47	14	31	03	35	08	01	18	11	23	14	13
14	21	38	14	13	03	11	08	24	18	26	23	17	14
15	21	28	13	54	02	48	08	46	18	41	23	20	15
16	21	19	13	35	02	25	09	08	18	57	23	23	16
17	21	08	13	16	02	02	09	30	19	11	23	25	17
18	20	58	12	56	01	38	09	53	19	25	23	26	18
19	20	47	12	37	01	15	10	14	19	39	23	28	19
20	20	36	12	17	00	52	10	36	19	53	23	29	20
21	20	24	11	57	00	28	10	57	20	06	23	29	21
22	20	12	11	37	00	05	11	18	20	19	23	28	22
23	20	00	11	16	S	19	11	39	20	31	23	27	23
24	19	47	10	56	00	42	12	00	20	43	23	26	24
25	19	34	10	35	01	05	12	21	20	55	23	24	25
26	19	21	10	14	01	29	12	41	21	06	23	22	26
27	19	07	09	53	01	52	13	02	21	17	23	19	27
28	18	53	09	32	02	16	13	22	21	28	23	16	28
29	18	39	09	10	02	39	13	42	21	38	23	13	29
30	18	25	08	49	03	03	14	02	21	48	23	09	30
31	18	10	08	27			14	21			23	04	31

A Table *of the Variation of the Sun's Declination, to every* 15 *Degrees of Longitude from the Meridian of* London.

Degrees of Longitude from the Meridian of London.

Daily Variat. Min.	*D.* 15 *M*	*D.* 30 *M*	*D.* 45 *M*	*D.* 60 *M*	*D.* 75 *M*	*D.* 90 *M*	*Deg.* 105 *Min.*	*Deg.* 120 *Min.*	*Deg.* 135 *Min.*	*Deg.* 150 *Min.*	*Deg.* 165 *Min.*	*Deg.* 180 *Min.*
2	00	00	00	00	00	00	01	01	01	01	01	01
3	00	00	00	00	01	01	01	01	01	01	01	01
4	00	00	00	01	01	01	01	02	02	02	02	02
5	00	00	01	01	01	01	01	02	02	02	02	02
6	00	00	01	01	01	01	02	02	02	02	03	03
7	00	01	01	01	01	02	02	03	03	03	03	03
8	00	01	01	01	02	02	02	03	03	03	04	04
9	00	01	01	01	02	02	03	03	03	04	04	04
10	00	01	01	02	02	02	03	03	04	04	05	05
11	00	01	01	02	02	03	03	04	04	05	05	05
12	00	01	01	02	02	03	03	04	04	05	05	06
13	01	01	02	02	03	03	04	04	05	05	06	06
14	01	01	02	02	03	03	04	05	05	06	06	07
15	01	01	02	02	03	04	04	05	06	06	07	07
16	01	01	02	03	03	04	05	05	06	07	07	08
17	01	01	02	03	04	04	05	06	06	07	08	08
18	01	01	02	03	04	04	05	06	07	07	08	09
19	01	02	02	03	04	05	06	06	07	08	09	09
20	01	02	02	03	04	05	06	06	07	08	09	10
21	01	02	03	03	04	05	06	07	08	09	10	10
22	01	02	03	04	05	05	06	07	08	09	10	11
23	01	02	03	04	05	06	07	08	09	10	11	11
24	01	02	03	04	05	06	07	08	09	10	11	12

A TABLE *of the Declinations of ſome of the moſt principal fixed Stars.*

Stars Names.	Declin.		Den.
S*CHEDAR*, in the Breaſt of *Caſſiopeia*	55	02	N
The bright Star of *Aries*	22	08	N
Algol, the Head of *Meduſa*	39	52	N
Aldebaran, the *Bull's Eye*	16	00	N
The *Goat* Star *Capella*	45	41	N
The Heart of *Hydra*	07	39	S
The Middlemoſt Star in *Orion*'s Belt	01	25	S
The Dog Star *Syrius*	16	24	S
Procyon, or the Little Dog Star	05	49	N
Caſtor, or the Head of the Northermoſt Twin	32	25	N
Pollux, or the Head of the Southermoſt Twin	28	36	N
Regulus, the *Lion*'s Heart	13	10	N
Deneb, the *Lion*'s Tail	16	00	N
The *Virgin*'s Spike	09	53	S
Antares, the *Scorpion*'s Heart	25	47	S
The Southermoſt of the two preceding Stars in the Square of the *Great Bear*	57	51	N
The Northermoſt of the ſame Two	63	13	N
The Southermoſt of the two following Stars in the Square of the *Great Bear*	55	13	N
The Northermoſt of the ſame Two	58	34	N
The Firſt in the Tail of the *Great Bear*	57	28	N
The Second in the Tail	56	22	N
The laſt of the Three in the Tail	50	42	N
Arcturus	20	26	N
Lyra, the bright Star in the *Harp*	38	33	N
Altair, the bright Star in the *Eagle*	08	10	N
The preceding of the two middlemoſt in the *Croſs*	57	11	S
The Northern Foot of the *Croſs*	55	30	S
The Southern Foot of the *Croſs*	61	31	S
The Eaſtermoſt of the four Stars in the *Croſs*	58	06	S

FINIS.